

Breast Augmentation: Cancer Concerns and Mammography—A Literature Review

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Learning Objectives: After studying this article, the participant should be able to: 1. Be familiar with the history of the controversy regarding breast cancer and breast augmentation. 2. Describe the characteristics of breast augmentation that affect detection of breast cancer. 3. Describe the modifications to standard mammography necessary to visualize the maximal amount of breast tissue in the augmented breast.

There has been a longstanding concern about whether there is an association between breast cancer and breast implants. This concern has served as the stimulus for many studies. Although there are data to support both sides, after our critical review of the literature, several conclusions can be drawn. (1) Augmented patients are not at a greater risk than the nonaugmented population for developing breast cancer. (2) Early detection of occult cancer is possible in augmented patients. (3) Submuscular placement allows for greater mammographic visualization. (4) Eklund views (displacement techniques) should be used when obtaining mammograms in augmented patients and should be interpreted by radiologists experienced in the evaluation of augmented patients. (5) Silicone and saline implants demonstrate the same radiodensity on mammograms; neither is superior to the other. (6) The current recommendations for getting screening/preoperative mammograms are no different for augmented patients, although the ultimate decision lies with each surgeon and patient. (*Plast. Reconstr. Surg.* 113: 117e, 2004.)

Augmentation mammaplasty is one of the most popular surgical procedures performed in plastic surgery, as more than 2 million procedures have been performed to date.¹ Furthermore, there continues to be a steady increase in the number of augmentations performed, with more than 215,000 performed in 2001 alone, representing an increase of 117 percent since 1997.² The popularity of breast augmentation has posed a new challenge to primary care physicians, plastic surgeons, and radiologists with respect to the detection of

breast cancer. With one out of eight women developing breast cancer,³ the need for early detection and treatment is paramount. Furthermore, there have been concerns not only that breast augmentation has resulted in an increase in the incidence of breast cancer but also that the breast cancers detected have been more advanced or aggressive.^{4–8} There have been many studies on these subjects, with data to support both sides. With a critical analysis of the literature, several conclusions can be drawn, and guidelines can be developed based upon those conclusions. That is the purpose of this review.

INCIDENCE OF BREAST CANCER AND BREAST AUGMENTATION

The original concern for an increase in breast cancer in augmented women was driven by two studies performed in the 1940s that demonstrated an increase in the incidence of sarcomas in rodents after implantation of foreign bodies.^{9,10} This solid-state carcinogenesis, or “Oppenheimer effect,” has not been borne out in humans, however.^{11–17} Several studies not only have refuted the correlation between sarcoma formation and breast implants but also have found there is no association with an increased incidence of breast carcinoma, as well.^{14–20} Some studies have actually reported a *decreased* incidence of breast cancer in aug-

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mented women.²¹⁻²⁴ In these prospective epidemiologic studies, the incidence of actual cases of breast cancer was significantly lower than the expected number of cases. This observation, combined with Ramasastry et al.'s²⁵ study in rodents demonstrating a reduction in tumorigenesis in the presence of expanders, suggests that the anticarcinogenic effect of implants may be justified. Deapen et al.²³ have suggested the following hypotheses for this observation:

- The implant causes a heightened immune response, leading to earlier detection and destruction of precancerous cells.
- The compression effect of the implant on surrounding breast tissue results in an alteration of cell growth rate.
- The implant acts as a body of insulation, lowering the ambient temperature of the breast, with subsequent reduction of the local tissue metabolic rates.

It is important to note, however, that although the sample sizes of these studies do not give them enough power to demonstrate a statistically significant decrease in the incidence of breast cancer in augmented women, it can be stated that the incidence of breast cancer in augmented women is *not* increased.¹⁴⁻²⁴

Diagnosis of Breast Cancer and Breast Augmentation

There is a widespread concern among women that breast implants hide or delay the diagnosis of breast cancer. This belief was supported by a series from Silverstein et al.⁴ in 1988 that found that all of their augmented patients presented with mammographically missed palpable breast lesions, of which 65 percent demonstrated histologically proven axillary node involvement. This finding was compared with those for nonaugmented patients, in whom mammography had shown a 69 percent detection rate of noninvasive cancers, with axillary node involvement as low as four percent. On the basis of this comparison, Silverstein et al. concluded that the delay in diagnosis and resultant poorer prognosis were a result of the breast implant.

Several follow-up studies did not support this conclusion. Silverstein et al.⁵ conducted their own follow-up study with a larger number of patients and found that the percentage of axillary node involvement detected in augmented versus nonaugmented patients was vir-

tually the same, in contrast to their earlier findings. Carlson et al.²⁶ demonstrated in their 1993 study that the pathological staging found in augmented versus nonaugmented women was similar. Deapen et al.^{15,18,23} came to the same conclusion. Leibman²⁷ and Leibman and Kruse²⁸ found that 28 percent of breast cancers detected in augmented patients were asymptomatic at the time of diagnosis, implying that even in augmented patients, breast cancer can be detected while still in its occult stages. Again, this contradicted earlier findings.

The pendulum has continued to swing in the direction of early detection of augmented patients. The largest study to date, performed by Birdsell et al.¹⁷ using the Canadian Cancer Registry, found that at the time of diagnosis, augmented patients had a significantly smaller tumor size as compared with their nonaugmented counterparts (65.9 percent ≤ 2 cm versus 34.1 percent ≤ 2 cm). The rates of axillary node metastasis (31.7 percent versus 30.0 percent) and distant metastasis (4.9 percent versus 5.0 percent) did not significantly differ between augmented and nonaugmented patients. Clark et al.²⁹ similarly reported in their series that augmented patients with breast cancer detected by physical examination had smaller tumors compared with their nonaugmented counterparts (79 percent ≤ 2 cm versus 51 percent ≤ 2 cm). In those patients presenting with palpable tumors, however, they found significantly lower rates of axillary node involvement (22 percent versus 58 percent) in augmented patients versus nonaugmented controls. The rates of axillary node metastasis, though, were not significantly different in those with mammographically detected tumors (13 percent versus 15 percent). Although no definitive explanation has been proven to support these findings, Birdsell et al.¹⁷ conjecture that the early diagnosis of breast cancer in augmented women is related to a "heightened body consciousness," with an increase in breast self-examination (and massage to prevent capsular contracture) in this subset of patients leading to early detection.

Types of Breast Cancer and Breast Augmentation

On the basis of the literature, the types of breast cancer detected in augmented versus nonaugmented patients are the same, with invasive ductal carcinoma the most common in both groups.^{14-20,24} Furthermore, the 5-year survival rate between augmented and nonaug-

mented patients actually favors the augmented patient, according to Birdsell et al.'s data (83 percent versus 74 percent).¹⁷ They found similar results at 10 years (73 percent versus 62 percent).¹⁷ This is thought to be the result of smaller tumor sizes being detected in the augmented patient, as previously described. Thus it can be concluded that breast cancer is *not* more aggressive in the augmented patient and that survival rates are similar.

Detection of Breast Cancer in the Augmented Patient

Although the goal of breast cancer detection is to find cancer before it reaches palpability, the average tumor size at the time of diagnosis in American women is 2.7 cm, with 40 percent axillary lymph node involvement.³⁰ Early, nonpalpable lesions are usually detected mammographically.^{31,32} The sensitivity of standard mammography has been questioned in augmented patients because the silicone and saline-filled implants can interfere with the ability to visualize breast tissue and diagnose suspicious lesions.^{4,7,26,33-35}

In mammography, the three-dimensional breast is reduced to a two-dimensional image with some breast tissue obscured by the shadow cast.³⁴ Furthermore, the quality of a mammogram depends on the compression of the breast, with more compression giving better visualization. With less compression, the volume of visualized tissue per square inch will increase, thus causing more superimposition and resulting in poorer image quality. A nonaugmented breast can usually be compressed to a thickness of 4.5 cm, whereas the augmented breast can be compressed to only 7.5 cm, obviously decreasing the quality of the mammogram.³⁶ Early reports estimated that only 25 percent of breast tissue can be visualized after breast augmentation.³⁷ Gumucio et al.³⁸ showed that both saline and silicone implants can totally obscure early lesions such as microcalcifications. Hayes et al.⁷ reported that 22 to 83 percent (average, 38 percent) of the breast tissue was obscured by the implant. Therefore, a standard mammogram, which compresses the breast tissue together with the implant, is not the best choice for augmented patients.

In 1988, Eklund et al.³⁹ developed the displacement technique, in which the implant is displaced posteriorly to allow a greater portion of the breast tissue to be visualized. Eklund et al. described 97 percent of the breast tissue being obscured by the implant, with a high potential for missing a significant lesion. The

displacement technique led to an improvement in 99 percent of the cases. This improvement was likely attributable to the fact that this technique resulted in a compression advantage of up to 5 cm, which improved image quality and sensitivity. Subsequent studies confirmed Eklund et al.'s results in obtaining better visualization of breast tissue using the displacement technique.^{27,28,35} Silverstein et al.³⁵ showed an eight percent increase in visualized tissue in patients with subglandular implants and a 10 percent increase in those with submuscular implants, compared with standard mammography. In general, it has been found that submuscular implant placement allows for greater visualization when compared with subglandular placement, regardless of breast size and implant type and size.^{35,40} Even with these increases, however, Silverstein et al.³⁵ found that only 85 percent of the breast tissue could be visualized. This is still less than the 90 percent (and above) that can typically be imaged in nonaugmented patients.³⁵ Despite this shortcoming, Leibman and Kruse²⁸ reported that 40 percent of the breast cancers were detected mammographically in augmented women, a rate that closely resembles that of the nonaugmented population.

Furthermore, factors such as capsular contracture can also affect mammogram sensitivity in augmented patients. Handel et al.⁴⁰ found that little or no capsular contracture resulted in a 30 percent decrease of visualized area, whereas moderate to severe contracture lead to a 50 percent decrease. This is because capsular contracture limited the ability to displace the implant posteriorly. In such cases, Eklund et al.³⁹ have added a 90-degree lateral view. In the most severe cases, standard compression and displacement mammography cannot be performed because of the rigidity of the surrounding tissue.⁴⁰

Augmented patients screened when younger than 45 years of age provide a further challenge. As in their nonaugmented counterparts, the breast tissue in these patients is denser as compared with older patients. This results in false-negative mammograms in up to 45 percent of patients.⁴¹

Other Modalities for Early Breast Cancer Detection in the Augmented Patient

Although mammography is the standard procedure for breast cancer screening, ultrasound, computed tomography, and magnetic

resonance imaging have also been used in select cases. Specifically, these modalities are used to differentiate breast masses from implant-related complications. Ultrasound can be helpful for the diagnosis of implant rupture and capsular contracture.^{42,43} Ultrasound cannot detect microcalcifications, however, and is therefore not a screening modality for breast cancer. Computed tomography can be used as an adjunct in select cases of implant rupture and in the differential diagnosis of cancer, but it is seldom used otherwise in breast cancer screening.⁴² Magnetic resonance imaging can fully visualize breast tissue in an augmented breast because of its ability to perform cross-sections easily, although to realize its full diagnostic capabilities, intravenous contrast medium is necessary.⁴² Scarring can be differentiated from malignancy, as malignant lesions demonstrate an early and strong enhancement of the contrast medium.^{44–48} Although magnetic resonance imaging has a sensitivity of 90 percent, its limited specificity is a known disadvantage, as malignant lesions can be mimicked by benign tumors, hormonal stimulation, and inflammatory changes.^{46–48}

Implant Material and the Detection of Breast Cancer

Gumucio et al.³⁸ conducted a study to determine the best filling material for implants to enable better radiographic detection of microcalcifications and soft-tissue masses. One outcome of this study, as stated above, was that silicone- and saline-filled implants can completely obscure early lesions, with both demonstrating the same radiodensities on a mammogram. Another outcome was that the best implants tested (in terms of radiodensity) were filled with peanut and sunflower oil.³⁸ It is very unlikely that these fillings will ever be approved because both are very likely to trigger a significant immune response, especially when implant rupture occurs. Currently, only saline implants are approved by the U.S. Food and Drug Administration (currently silicone is only available if the patient is enrolled onto a specific study protocol), and the plastic surgeon has no other choice until research has found improved implants in terms of visualization. On the basis of this study, we can expect similar imaging results in saline and silicone implants.

Recommendations for Screening in Augmented Patients

The current guidelines for breast cancer screening in women can vary depending on the organization. Although the American Cancer Society recommends mammograms annually after age 40,⁴⁹ the conglomeration of recommendations is that, at a minimum, women between the ages of 40 and 69 should have a mammogram every 1 to 2 years.^{50–55} These recommendations hold for augmented and non-augmented women.

Some studies have suggested that modifications be made for augmented patients. Silverstein et al.⁴ have recommended that all patients with breasts that are difficult to examine, as well as patients older than 30 years, should have preoperative mammograms, with their mammograms read by radiologists experienced with augmented patients. Furthermore, patients with a strong family history of breast cancer, with a personal history of breast cancer, or a history of severe atypical hyperplasia should have preoperative mammograms and yearly mammograms after the age of 35.

To date, there have been no studies to definitively prove that preoperative screening is efficient in detecting occult breast cancer in patients younger than 40 seeking augmentation. Ultimately, the decision lies with the patient and the surgeon. It should be noted (as stated above) that despite improved mammography techniques, patients must understand that postoperative images will be more difficult to interpret and of inferior quality.⁴⁰ Regardless, new breast masses around implants should always include a possible malignancy in the workup, and the diagnosis of capsular contracture and scarring should be thoroughly evaluated. The threshold to obtain a tissue diagnosis must be low if the slightest doubt persists.

CONCLUSIONS

In the final analysis, the initial fears that augmented patients were at greater risk for breast cancer (and for more aggressive types of breast cancer) have not turned out to be true. After a critical analysis of the available data, the following conclusions can be drawn: (1) augmented patients are not at a greater risk than the nonaugmented population for developing breast cancer; (2) early detection of occult cancer is possible in augmented patients; (3) sub-muscular placement allows for greater mam-

mographic visualization; (4) Eklund views (displacement techniques) should be used when obtaining mammograms in augmented patients and should be interpreted by radiologists experienced in the evaluation of augmented patients; (5) silicone and saline implants demonstrate the same radiodensity on a mammogram; neither is superior to the other; and (6) the current recommendations for getting screening/preoperative mammograms are no different than those for augmented patients, although the ultimate decision lies with each surgeon and patient.

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