Improved Imaging of the Augmented Breast

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The breast containing an augmentation implant presents a challenge to the mammographer and is often considered unsuitable for adequate mammographic evaluation. A modified positioning technique is described. By displacing the implant posteriorly against the chest wall and pulling breast tissue over and in front of the implant, marked improvement in compression and visualization of substantially more breast tissue is achieved. Over 250 patients with augmentation implants have been successfully studied with this modified compression technique. After review of 50 consecutive cases, two experienced mammographers confirmed a significant improvement in image quality, amount of breast tissue visualized, and overall benefit of the modified technique.

Modified positioning for women with breast implants substantially improves both image quality and amount of breast tissue imaged.

An estimated 150,000 women undergo augmentation mammoplasty annually in the United States. Mammographers are being challenged, with increasing frequency, to perform mammography in these patients. Many clinicians and some radiologists assume erroneously that the presence of an implant usually renders the study of limited or no practical value. The purpose of this study was to evaluate a modified technique for pulling breast tissue away from the implant and image with most, and in some cases all, of the implant excluded from the compression field.

Subjects and Methods

Fifty consecutive patients with breast augmentations form the basis of this study. Excluded were patients with reconstruction after mastectomy. No attempt was made to group patients according to the type of implant or the position of the implant with regard to the pectoral muscle. All examinations were performed on CGR Senograph 500 (Thompson CGR, Columbia, MD) dedicated mammographic units. Two of the three units were equipped with manual compression systems; the third unit was equipped with an automated pneumatic compression device. All examinations were performed with film/screen technique, single-emulsion film, and rare-earth screens.

Standard 45° mediolateral oblique and craniocaudal views, with the implant included in the compression field, were obtained of each breast. These were followed by modified compression views obtained in similar oblique and craniocaudal projections.

The two-step modified compression technique used for all patients in the study consisted of first pulling breast tissue over and in front of the implant while the compression paddle was applied (Fig. 1A). The second step, performed simultaneously with the first, involved posterior displacement and flattening of the implant against the chest wall while compressing breast tissue, with little or none of the implant included under the paddle (Figs. 1A–1C).

A 90° mediolateral view was added for those patients in whom the implant was rigidly encapsulated. The presence of firm encapsulation was determined by the technologist if not already indicated by the referring physician. The hard, incompressible character of the encapsulated implant is quite obvious to the technologist as the patient is positioned. Encapsulation often prevents adequate compression of the breast tissue and posterior

Received October 1, 1987; accepted after revision May 13, 1988.

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AJR 151:469–473, September 1988
0361–803X/88/1513–0469

American Journal of Roentgenology 1988.151:469-473.

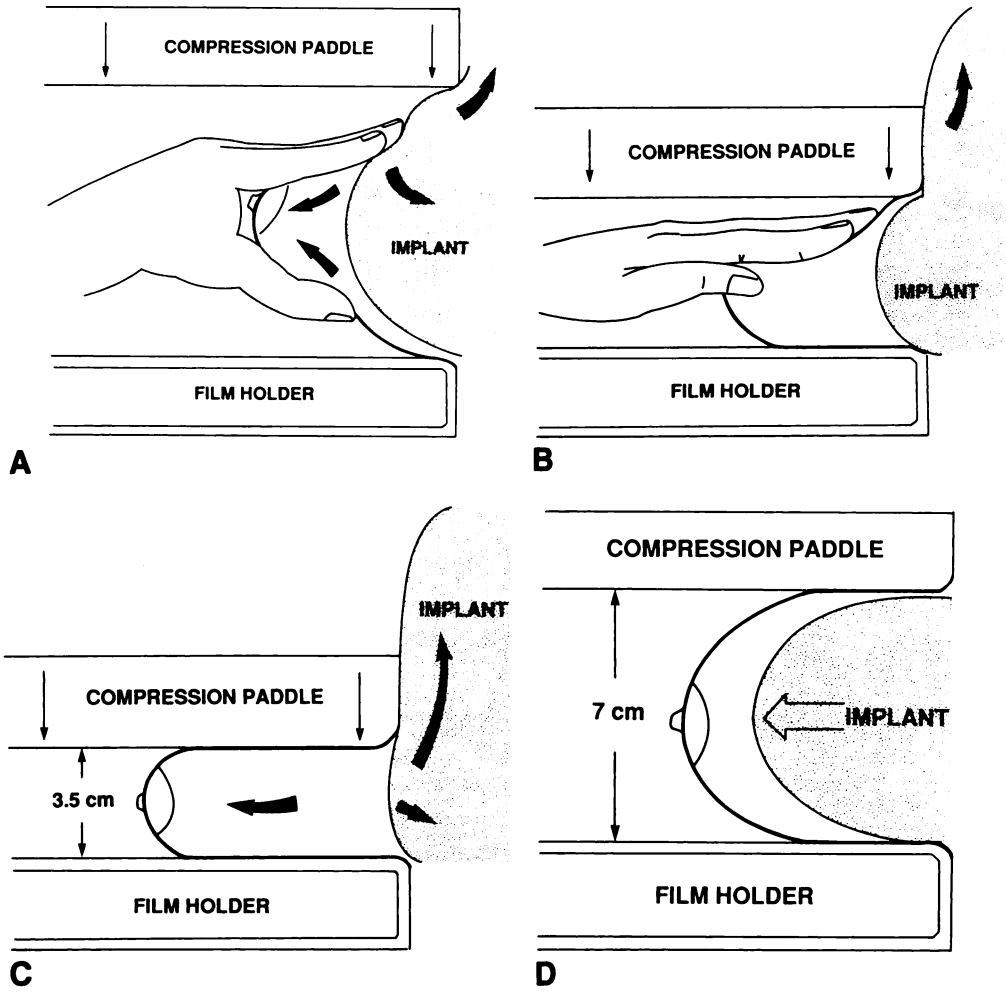

Fig. 1.—Technique and advantage of modified compression relative to limitations imposed by inclusion of implant in compression field.

***A* and *B*, Modified compression views begin with pulling of breast tissue over and in front of implant, while hand and compression paddle push implant posteriorly as breast tissue is compressed.**

***C*, Breast tissue has been brought into field with compression displacing implant posteriorly and excluding it from field.**

***D*, Breast compressed together with implant results in implant being driven forward, compacting breast tissue and significantly limiting degree of compression.**

American Journal of Roentgenology 1988.151:469-473.

displacement of the implant. When there was clinical concern for lesions cephalad to the implant between the 11:00 o'clock and 1:00 o'clock positions or caudad to the implant between the 5:00 and 7:00 o'clock positions, the 90° lateral view was useful (Fig. 2). An additional view was obtained tangential to the areas of clinical or radiographic concern, which were not projected free of the implant on other views. Focal compression and magnified images were obtained when needed to resolve areas in question and to better evaluate microcalcifications (Fig. 3). Lead markers were applied to the skin surface to identify areas of clinical concern. Manual techniques were used for all standard views of the breast. Phototiming was used for the modified compression views.

Two radiologists experienced in film-screen mammography reviewed a series of 50 consecutive mammograms obtained with the modified compression technique. Each radiologist was asked to evaluate the standard compression views first and then to evaluate both standard and modified compression views together. General acceptability and overall quality of the standard technique were ranked, and the estimated amount of breast tissue obscured and the potential for missing significant lesions were described. The modified compression technique was then evaluated with regard to (1) degree of additional compression, (2) amount of additional breast tissue visualized, (3) overall improvement in image detail, and (4) overall value as an added technique. The 50 cases included 13 subpectoral implants and 37 intramammary implants. Six patients had clinically apparent firm, fibrous encapsulation of intramammary implants and one had a firm encapsulation of a subpectoral implant.

Results

Conclusions from the review of 50 cases are listed in Table 1. Acceptability of the standard technique images was 99%. One observer thought that one of the studies should have been repeated because of an overexposed technique. In 97.9% of the standard compression cases, moderate or marked amounts of breast tissue were described as being obscured by the implants (Fig. 4). The potential for missing significant lesions was rated high in 59% and moderate in 40% of these cases.

In comparing the advantages of the modified compression technique with the standard technique, the observers judged that 99% of the cases showed marked to moderate improvement in compression. Ninety-nine percent showed marked to moderate amounts of additional breast tissue. All cases were thought to show improved image detail (Fig. 5), and in all cases, modified compression was judged of marked to moderate value as an added technique for imaging patients with implants (Table 1).

Discussion

The most posterior breast tissue medially and laterally often was seen only with the standard craniocaudal view obtained

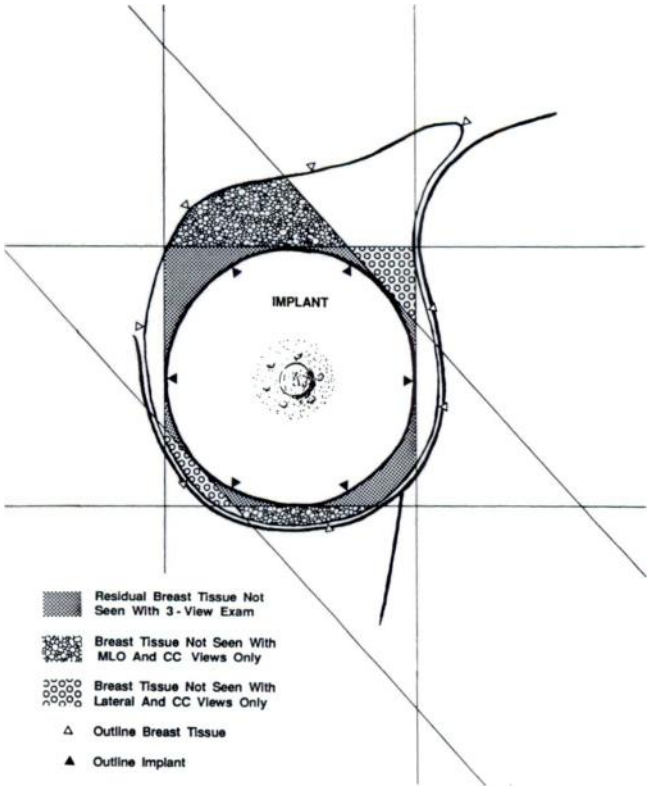

Fig. 2.—*Shaded areas* on schematic drawing show tissue obscured by implant when standard mediolateral oblique (MLO), craniocaudal (CC), and 90° lateral compression views are used.

with the compression paddle against the chest wall, compressing the breast and implant together. Likewise, the most posterior corresponding portions of the breast may be best seen with the standard oblique or lateral views. For this reason, we continue to include the standard views in our protocol for imaging the augmented breast.

In our experience, 15–20% of patients have noticeable fibrous encapsulation of the implant. This limits the ability to flatten the implant and displace it posteriorly against the chest wall. However, one can still pull significantly more breast tissue over in front of the implant and can achieve 3–5 cm more compression by "excluding" the implant from compression. We have added the 90° lateral view in such patients to compensate for the failure to image more of the tissue immediately above and below the implant (Fig. 2).

Localized areas of clinical concern or questionable areas on mammograms were seen better with focal compression views, with or without magnification. The focal compression paddle was applied while the breast tissue was being pulled over and in front of the implant, compressing only breast tissue whenever possible. Magnified images increased the confidence with which decisions were made regarding microcalcifications and suspicious densities (Fig. 3B).

Marked improvement in image quality resulted from the greater degree of compression achieved without the limiting effect of the implant. In some cases, there was as much as a 5-cm difference in the degree of compression. In most cases, a 2- to 4-cm compression advantage was achieved.

Compression of the implant and breast together compacted the breast tissue between the implant and the skin, while

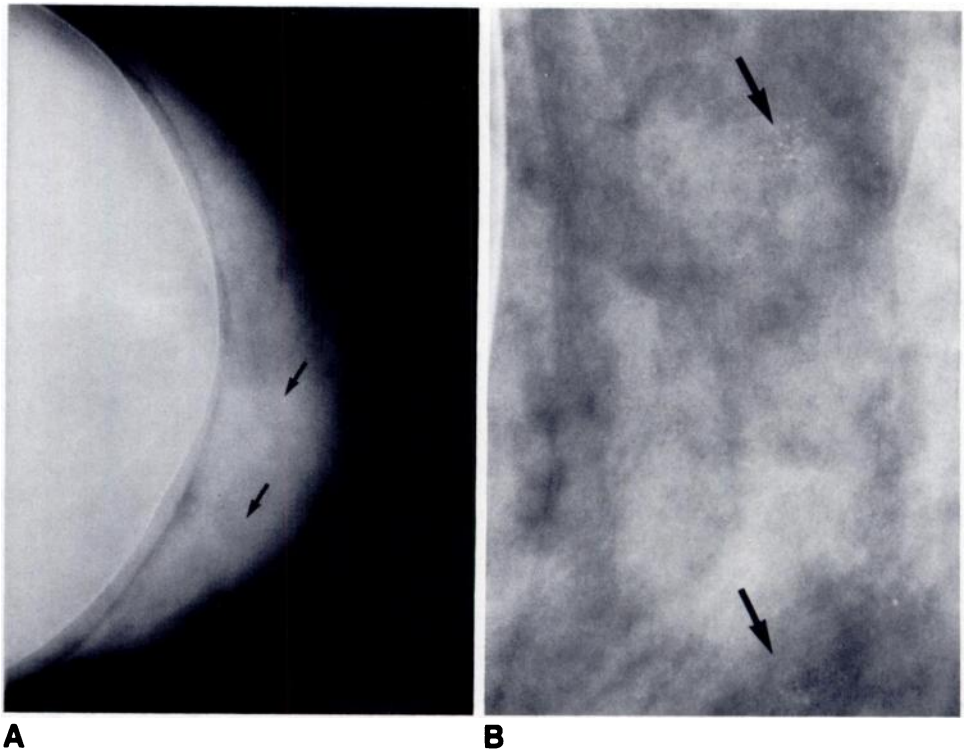

Fig. 3.—Mammograms show benefit of focal compression magnified image for detection of microcalcifications.

***A*, Standard compression craniocaudal view shows subtle calcifications (*arrows*) poorly.**

***B*, Modified compression magnified image shows two clusters of microcalcifications (*arrows*). Pathologic diagnosis: atypical ductal hyperplasia in one cluster, intraductal carcinoma in other.**

limiting the degree to which it could be compressed (Fig. 1D). Compacted and suboptimally compressed fatty breast tissue appeared as dense glandular tissue on the radiograph.

No rupture of a prosthesis has occurred in any of the patients studied with the combined standard and modified compression technique. In the 18 years of mammography experience of one of the authors, no prosthesis has ruptured and only one "closed capsulotomy" occurred while standard compression craniocaudal views were being obtained. In the case of the closed capsulotomy, the patient was referred to a plastic surgeon and promptly treated with a closed capsulotomy of the opposite breast with excellent results.

TABLE 1: Comparison of Standard and Modified Compression Mammographic Studies in Patients with Breast Implants

Technique: criterion	No. (%)		Average %
	Observer 1 (n = 46)	Observer 2 (n = 50)	
Standard compression views:			
General acceptability and overall quality:			
Acceptable	45 (97.8)	50 (100)	99
Not acceptable	1 (2.2)	0 (0)	1
Amount of breast tissue obscured by implant:			
Large	24 (52.2)	36 (72)	62.1
Moderate	21 (45.6)	13 (26)	35.8
Small	1 (2.2)	1 (2)	2.1
Potential for missing significant lesions:			
High	23 (50)	34 (68)	59
Moderate	23 (50)	15 (30)	40
Low	0 (0)	1 (2)	1
Modifed compression views:			
Improved compression:			
Marked	39 (84.8)	45 (90)	87.4
Moderate	7 (15.2)	5 (10)	12.6
Slight	0	0 (0)	0
Additional breast tissue visualized:			
Marked	38 (82.6)	38 (76)	79.3
Moderate	8 (17.4)	11 (22)	19.7
Slight	0 (0)	1 (2)	1
Improved image detail:			
Marked	43 (93.5)	47 (94)	93.7
Moderate	3 (6.5)	3 (6)	6.3
Overall value as an added technique:			
Marked	42 (91.3)	47 (94)	92.7
Moderate	4 (8.7)	3 (6)	7.3

The limitations of conventional imaging techniques for evaluating the augmented breast have resulted in suboptimal mammographic studies and considerable frustration for the clinician and mammographer. Reports in the surgical and radiologic literature have questioned the role of mammography in patients with augmentation implants [1–5]. Erroneous assumptions regarding the limitations imposed by implants on adequate mammographic evaluation have received media attention and have been reported in the lay literature [6]. Silicone injection techniques, currently banned by the U. S. Food and Drug Administration, have led to inconclusive mammographic findings [7].

Cohen et al. [8] compared five patients who had saline-filled implants with five who had silicone gel implants, noting that saline-filled implants afforded better radiographic visualization through the implant than the more radiopaque silicone gel. Although high-density masses occasionally may be seen through saline implants, low-density lesions and most fine microcalcifications will be obscured. There is a substantial potential for missing an early breast cancer if one assumes that breast tissue is adequately visualized by seeing it through a low-density implant. Silverstein [9] reported 20 patients with silicone implants who developed breast carcinoma not detected by initial mammographic studies. All the cancers were invasive, and 60% of the patients had positive nodes at the time of diagnosis. He attributed the delay in diagnosis to limitations imposed by the implants on mammographic imaging. Even in the nonaugmented breast, identifying occult signs of malignancy often depends on adequate compression. Sonography has been proposed as a method for evaluating breast tissue obscured by implants [10, 11]. Although sonography remains the imaging technique of choice for differentiating solid from cystic lesions, most occult noninvasive carcinomas are not identifiable with sonography [11].

In the patient who has an augmentation implant, the challenge is to visualize the maximum amount of breast tissue

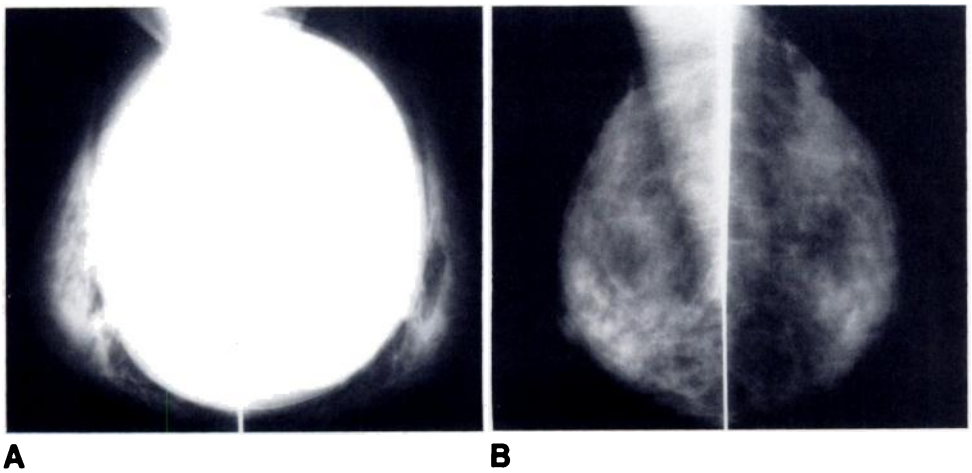

Fig. 4.—Augmented breast on standard and modified compression mammograms.

***A*, Standard compression mediolateral view that includes implant limits degree of compression and results in "compacting" of breast tissue between implant and skin.**

***B*, With modified compression, implant is pushed back against chest wall, allowing better compression of breast tissue "free" of implant.**

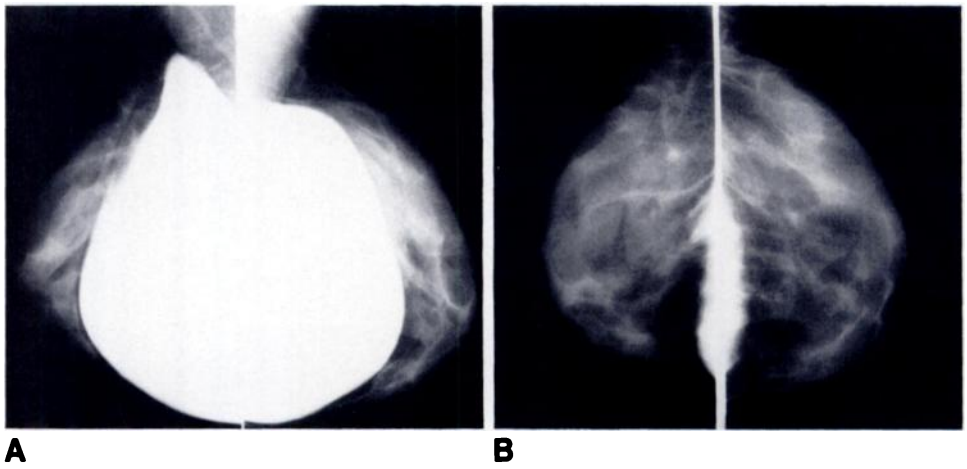

Fig. 5.—Augmented breast on standard and modified compression mammograms.

***A*, Standard compression view with implant included.**

***B*, Modified compression view with improved compression of more breast tissue. Small amount of implant is visible in field posteriorly.**

"free" of the implant, with optimal compression and maximum image detail. The modified compression technique allows 2–5 cm additional breast compression in most patients when little or no implant is included in the field of compression. In those patients with rigid encapsulation or in whom posterior displacement of the implant was limited, the modified compression technique failed to visualize breast tissue that remained posteriorly around the periphery of the implant. This posterior peripheral breast tissue was best seen on the standard views. The occasional addition of a 90° lateral projection provided better visualization of posterior breast tissue immediately above and below an implant, especially in the case of rigid encapsulation (Fig. 2).

Mammographers have been reluctant to compress the augmented breast for fear of damaging the implant and causing discomfort to the patient. Some patients with implants and their clinicians have similar, if not greater, anxiety about the possibility of implant damage by the compression procedure. It is important for mammographers to recognize that this fear is unfounded and to provide the needed reassurance. A patient's anxiety contributes to discomfort and reluctance to allow adequate compression. Patients with subpectoral implants often have considerable pain when the pectoral muscle is compressed and may need even more reassurance. Knowledge by the mammographer regarding the type and location of the implant before the mammographic study will enable positioning and compression considerations to minimize the patient's discomfort and enhance the quality of the study. Frequently, the referring clinician and the patient are unaware of the type of implant. Plastic surgeons should be encouraged to inform patients that this information will be helpful to the mammographer during future mammographic studies and that, with modified techniques, high-quality mammograms can be obtained. Patients with augmentation implants should be encouraged to participate in breast cancer screening programs according to recommended guidelines.

ACKNOWLEDGMENTS

We thank Audrey Weitzel and Laurie Mahar for help in developing this technique and Robert Craven and David Wright for assistance in reviewing our cases.

REFERENCES

1. Parsons RW, Thering HR. Management of the silicone-injected breast. *Plast Reconstr Surg* **1977**;60:534–538
2. Koides T, Katayama H. Calcification in augmentation mammoplasty. *Radiology* **1979**;130:337–340
3. Grant EG, Cigtay OS, Mascatello VJ. Irregularity of silastic breast implants mimicking a soft tissue mass. *AJR* **1978**;130:461–462
4. Rosenbaum JL, Bernadino ME, Thomas JL, Wigley KD. Ultrasonographic findings in silicone augmented breasts. *South Med J* **1981**;74:455–458
5. Jensen R, Mackey JK. Xeromammography after augmentation mammoplasty. *AJR* **1985**;144:629–633
6. News from the world of medicine. *Reader's Digest* **1987**;Nov:63
7. Timberlake GA, Looney GR. Adenocarcinoma of the breast associated with silicone injections. *J Surg Oncol* **1986**;32:79–81
8. Cohen IK, Goodman H, Theogaraj SD. Xeromammography: a reason for using saline-filled breast prosthesis. *Plast Reconstr Surg* **1977**;59:886–888
9. Silverstein MJ. Augmentation mammoplasty: its effect on breast diagnosis and treatment. In: *Breast Center Foundation Newsletter*, vol. 2., no. 4. Van Nuys, CA: Van Nuys Breast Clinic, **1987**
10. Cole-Beuglet C, Schwartz G, Kurtz AB, Patchefsky AS, Goldberg BB. Ultrasound mammography for the augmented breast. *Radiology* **1983**;146:737–742
11. Harper P. *Ultrasound mammography*. Baltimore: University Park, **1985**:103–104