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# Imaging Surveillance After Breast-Conserving Surgery for Cancer With Acellular Dermal Matrix Reconstruction

Da Won Jung[1], Jin Chung[1]*, Ji Min Kim[2], Eun Suk Cha[1], Jeoung Hyun Kim[1]

[1]Department of Radiology, Ewha Womans University Mokdong Hospital, Seoul, Republic of Korea
[2]Department of Pathology, Ewha Womans University Mokdong Hospital, Seoul, Republic of Korea

**Objective:** The aim of this study was to investigate postoperative imaging findings of patients who underwent breast-conserving surgery for cancer and reconstruction with MegaDerm® (sheet-type and pellet-type), analyzing false positives and recurrences, using multi-modality images.

**Materials and Methods:** This study included 201 women (age range: 28–81 years, mean age ± standard deviation: 53.2 ± 8.6 years) who underwent breast-conserving surgery and immediate reconstruction with MegaDerm®. Post-surgery, each patient underwent at least one mammography (MG), ultrasonography (US), and MRI, totaling 713 MG, 1063 US, and 607 MRI examinations. Postoperative images were reviewed separately for the two types of MegaDerm®, and suspicious imaging findings (false positives and recurrences) were analyzed, with a particular focus on the findings in direct contact with MegaDerm®.

**Results:** MegaDerm® appeared as a circumscribed mass with homogeneous iso- or high density on MG, posterior shadowing on US, and no enhancement on MRI. Calcification was more common and increased in size in sheet-type MegaDerm®, while pellet-type often exhibited irregular margins. Nine out of 17 false positives had suspicious findings in direct contact with MegaDerm®, and six out of nine recurrences showed similar findings. Common suspicious findings included calcifications, asymmetries, and MegaDerm® irregularities on MG; masses and MegaDerm® irregularities on US; and enhancing masses and MegaDerm® irregularities with enhancement on MRI. Notably, MegaDerm® irregularity with calcification was observed on MG and US in only one recurrence case. In 44.4% (4/9) of false-positives in direct contact with MegaDerm®, suspicious findings showed no change or resolution on follow-up.

**Conclusion:** Suspicious imaging findings in direct contact with MegaDerm® may be associated with false positives or recurrences. Therefore, it is essential to recognize these characteristic findings and review the patient's history of MegaDerm® insertion when in doubt.

**Keywords:** Acellular dermal matrix; Breast cancer; Magnetic resonance imaging; Mammography; Ultrasonography

## INTRODUCTION

The increasing safety of breast-conserving surgery (BCS) and reconstruction has led to favorable cosmetic outcomes for early-stage breast cancer, resulting in improved quality of life [1,2]. In implant-based breast reconstruction, acellular dermal matrix (ADM) was first introduced to correct implant rippling and symmastia after breast implant surgery. However, ADM has been increasingly utilized as a volume filler in BCS [3,4]. MegaDerm® (L&C BIO, Seongnam, Korea) is an exceptional cross-linking human ADM, processed via AlloClean® technology that inactivates cell debris, antigens, and latent viruses, preserving structural integrity, making it an ideal biological tissue substitute [5].

Concerns persist regarding effectively monitoring tumor recurrence during postoperative surveillance. For patients who have undergone BCS, early and accurate tumor recurrence detection is crucial for improving overall survival rate [4,5]. However, ADM can complicate the interpretation of conventional imaging modalities, such

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**Corresponding author:** Jin Chung, MD, PhD, Department of Radiology, Ewha Womans University Mokdong Hospital, 1071 Anyangcheon-ro, Yangcheon-gu, Seoul 07985, Republic of Korea
• E-mail: aqua0724@ewha.ac.kr

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as mammography (MG) and ultrasonography (US), because it can resemble a mass-like lesion, potentially mimicking malignancy [6]. Therefore, providers must be knowledgeable about imaging findings and establish comprehensive postoperative surveillance strategies to optimize tumor recurrence identification. MG remains the only recommended postoperative imaging modality; however, the roles of additional modalities are not yetfirmly established [7,8]. Few reports have explored the imaging findings of patients using MegaDerm® [6,9]. Only a few case reports have simultaneously compared the results of the three imaging modalities (MG, US, and MRI) [10,11]. However, no studies have compared radiologic findings for both types of MegaDerm®.

The aim of this study was to investigate the postoperative imaging findings of patients who underwent BCS for cancer and reconstruction with MegaDerm® (sheet-type and pellet-type) using multi-modality imaging (MG, US, and MRI) and to analyze suspicious imaging findings with false positives and recurrences by focusing on findings in direct contact with MegaDerm®.

## MATERIALS AND METHODS

### Study Population

Our Institutional Review Board approved this retrospective study and waived the requirement for informed consent (IRB No. 2023-04-017).

We collected postoperative images between August 2016 and August 2022 of women who underwent BCS and immediate reconstruction with MegaDerm® between January 2015 and August 2021. We excluded one patient with MRIs obtained outside the institution, two with breast implant augmentation, and four who were confirmed to have secondary breast cancer. Finally, we identified 201 women (age range: 28–81 years, mean age ± standard deviation: 53.2 ± 8.6 years) who had undergone at least one MG, US, and MRI for postoperative surveillance. In total, 713 MG (range 2–7 rounds, mean 3.7 rounds per patient), 1063 US (range 2–10 rounds, mean 5.3 rounds per patient), and 607 MR (range 2–6 rounds, mean 3.2 rounds per patient) images were included. The number of examinations performed for each MegaDerm® type is shown in Figure 1. The pathologic types of breast cancer included invasive ductal carcinoma (n = 145), ductal carcinoma in situ (n = 37), invasive lobular carcinoma (n = 7), mucinous carcinoma (n = 7),

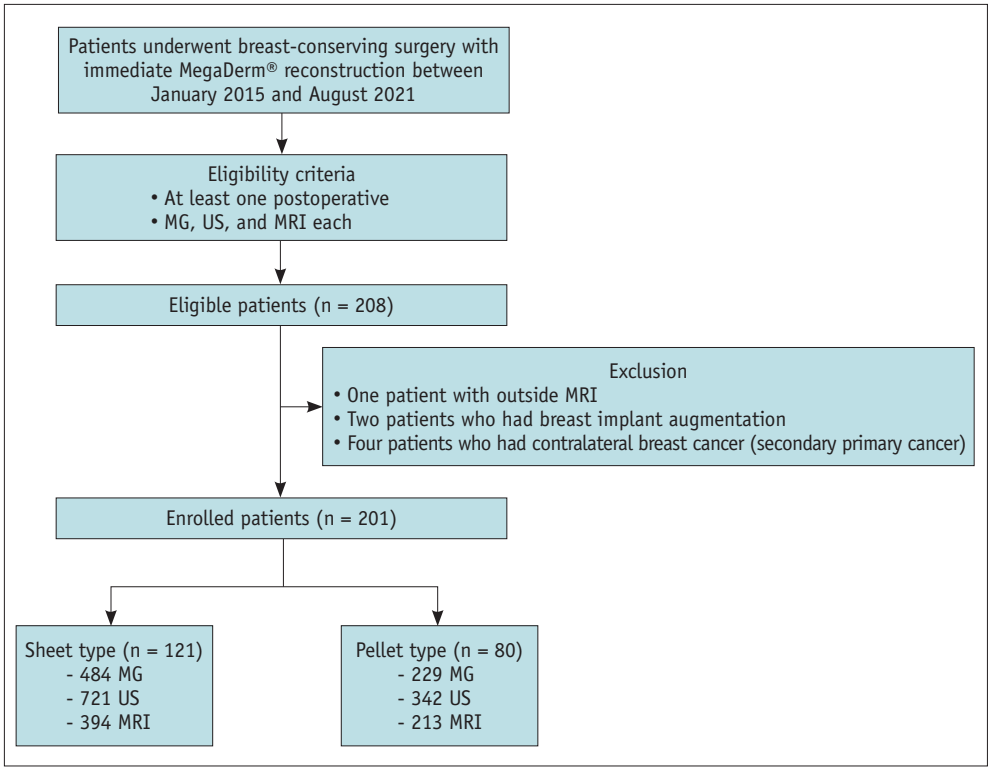


**Fig. 1.** Flowchart of the study population. MG = mammography, US = ultrasonography


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solid papillary carcinoma (n = 2), metaplastic carcinoma (n = 1), invasive neuroendocrine carcinoma (n = 1), and invasive cribriform carcinoma (n = 1). The mean time from the first breast surgery to August 2022 was 35.5 months (range, 12–71 months).

MegaDerm® is available in sheet-type and pellet-type forms. Initially, the sheet type was used, and over time, there was a transition to the pellet type. In our study, 121 (60.2%) underwent breast reconstruction using the sheet-type MegaDerm®, while the remaining 80 (39.8%) received the pellet-type MegaDerm® insertion. Supplementary Figures 1 and 2 show surgical sections after mastectomy following two different types of MegaDerm® insertion.

### Data Collection

We retrospectively reviewed pathologic reports and radiologic categories of postoperative images for all patients using electronic medical records and a picture-archiving and communication system. We examined suspicious findings in the same quadrant as the surgical site, defined as the 'operative bed,' and confirmed whether they were false positives or recurrences, we then separately analyzed a subgroup of suspicious findings in direct contact with MegaDerm®.

Furthermore, we categorized molecular subtypes of initial and recurrent breast cancers in recurrence cases as follows: luminal A (hormone receptor [HR]-positive and human epidermal growth factor receptor 2 [HER2]-negative), luminal B (HR-positive and HER2-positive), HER2-positive (HR-negative and HER2-positive), and triple-negative breast cancer (HR-negative and HER2-negative).

### Postoperative Imaging Acquisition

Our institution recommends that patients with a personal history of breast cancer receive annual MG and breast US every 6–12 months. Postoperative breast MRI is usually performed with MG annually under the reimbursement policy of the Korea National Health Insurance Service. Surveillance intervals (annual or semiannual) were determined by referring surgeons based on the patient's risk factors.

A Dimension (Hologic, Bedford, MA, USA) MG system was used for digital MG, which included craniocaudal and mediolateral oblique views. Handheld whole-breast US, including color Doppler, was performed by one of five board-certified radiologists with 2 to 25 years of experience in breast imaging. US images were acquired using a 7.5–15 MHz linear-array transducer from either the iu22 scanner (Philips Medical Systems, Bothell, WA, USA), the GE LOGIQ9 (GE Medical Systems, Milwaukee, WI, USA), or the Aixplorer system (Supersonic Imagine, Aix en Provence, France). Of the 607 breast MRIs, 307 were conducted using a 1.5T MR system (Magnetom Avanto [Siemens]). The remaining 300 were performed using a 3T MR system (Achieva [Philips Healthcare] or Magnetom Vida [Siemens]). The breast MRI protocol changed during the study period. Until August 2017, we used the full MRI protocol, which included a T2-weighted sequence, one pre-contrast T1-weighted sequence, and six post-contrast T1-weighted sequences. Furthermore, diffusion-weighted images (b values of 0 and 800) and kinetics analysis were performed in the full protocol MRI. Beginning in August 2017, an abbreviated breast MRI protocol was implemented, involving a T2-weighted sequence, one pre-contrast T1-weighted sequence, and two post-contrast images. In this abbreviated MRI protocol, the second contrast sequence was acquired four minutes after the first post-contrast sequence, resulting in a total acquisition time of nine minutes.

### Postoperative Imaging Interpretation

One of five board-certified radiologists with 2 to 25 years of experience in breast imaging interpreted the postoperative images. Images from each modality were assessed according to the 5th edition of the Breast Imaging Reporting and Data System (BI-RADS) classification, which includes categories 0, 1, 2, 3, 4A, 4B, 4C, or 5. For this study, BI-RADS categories 0, 4, and 5 were classified as positive imaging results. For BI-RADS category 0, the final assessment was recorded rather than the initial. When the lesion was categorized as BI-RADS category 4 or 5, subsequent tissue confirmation was conducted through imaging-guided biopsy and/or excision. For BI-RADS categories 1–3, follow-up of more than one year was required to confirm benign findings.

We retrospectively analyzed newly developed calcifications at the surgical site on each patients' most recent MG during the study period. Calcifications were categorized into micro-calcification and macro-calcification based on size [12]. If both types were mixed, it was classified as the predominant type.

On MG, suspicious findings in direct contact with MegaDerm® included new suspicious calcifications within or around MegaDerm® (Fig. 2), asymmetries attached to MegaDerm®, or peripheral irregularities of MegaDerm®. On US, they appeared mainly as new masses in direct contact with MegaDerm® (Fig. 3) but also as peripheral irregularities


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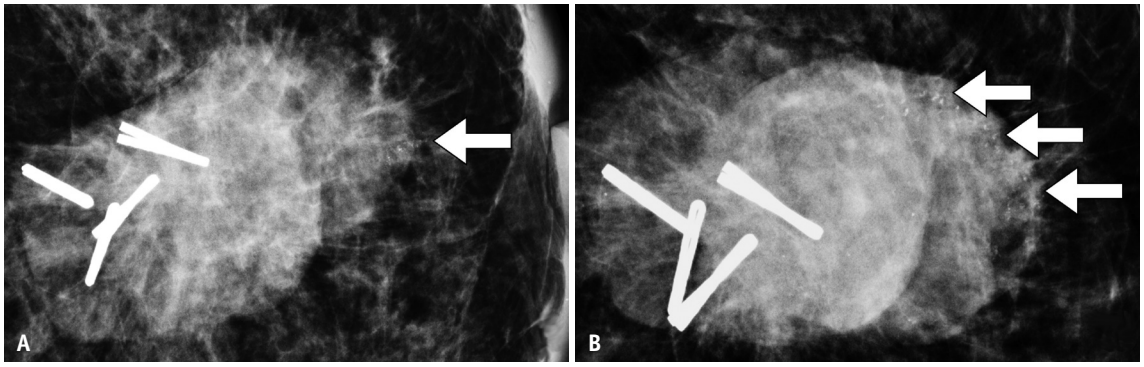


**Fig. 2.** A 58-year-old woman with a false positive in direct contact with MegaDerm® detected by mammography 23 months after left BCS and sheet-type MegaDerm® insertion (Patient no. 1 in Table 2). **A:** Left craniocaudal view mammogram (zoomed-in image) showed grouped amorphous micro-calcifications (arrow) at the anterior aspect of sheet-type MegaDerm®, which was assessed as BI-RADS category 4A. Ultrasonography and MRI performed on the same day showed no suspicious findings (not shown), so short-term follow-up was recommended. **B:** After one year, a follow-up left craniocaudal view mammogram (zoomed-in image) showed micro-calcifications along the margin of MegaDerm® (arrows), as the number and size increased with a punctuate appearance, and it was thought to be benign post-surgical calcifications (downgraded to BI-RADS category 3). There was no recurrence in one year. BCS = breast-conserving surgery, BI-RADS = Breast Imaging Reporting and Data System

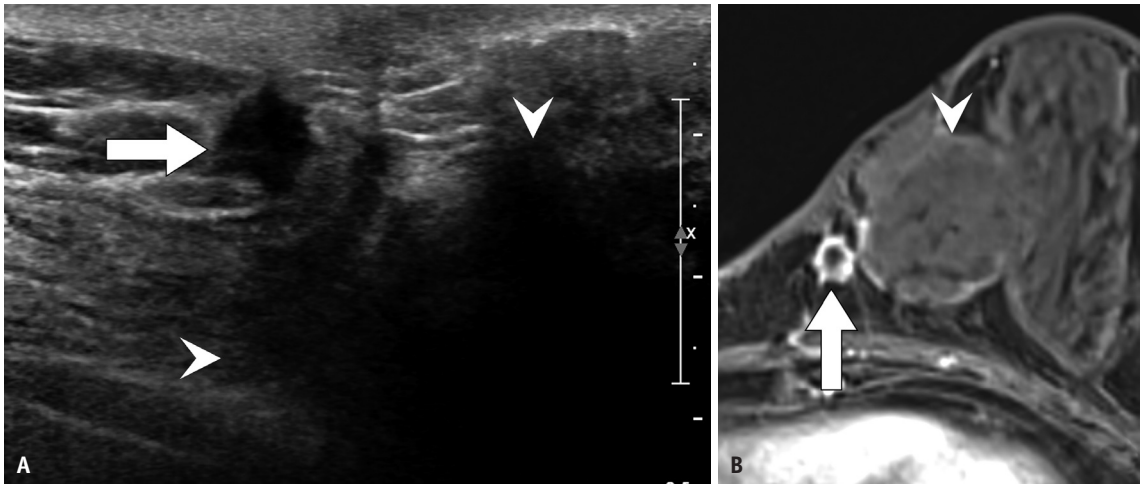


**Fig. 3.** A 52-year-old woman with recurrence in direct contact with MegaDerm® in postoperative surveillance 13 months after left BCS and pellet-type MegaDerm® insertion (Patient no. 8 in Table 3). **A:** US image showed a 0.8-cm hypoechoic mass (arrow) attached to the inner aspect of MegaDerm®. The pellet-type MegaDerm® exhibited irregular margins (arrowheads) and posterior shadowing. **B:** T1-weighted contrast-enhanced fat-suppressed MRI image showed a rim-enhancing mass (arrow) attached to the inner aspect of MegaDerm® (arrowhead). Pellet-type MegaDerm® did not exhibit enhancement. The mass was confirmed as a recurrent cancer by US-guided biopsy. BCS = breast-conserving surgery, US = ultrasonography

of MegaDerm® (Figs. 4, 5). On MRI, they appeared as new enhancing masses in direct contact with MegaDerm® or irregularities with abnormal contrast enhancement around MegaDerm® (Figs. 5, 6). Non-mass enhancement along the peripheral aspect of MegaDerm® appeared as MegaDerm® irregularity with enhancement.

### Statistical Analysis

We retrospectively reviewed imaging findings of the two types of MegaDerm® on each modality separately. Calcification characteristics on MG were compared between sheet- and pellet-type and analyzed using the chi-square test, which was performed with the SPSS software (version 26; IBM Corp., Armonk, NY, USA). Differences were considered statistically significant if $P < 0.05$. The diagnostic performance of three imaging modalities (MG, US, and MRI) was evaluated using metrics such as sensitivity and specificity. True-positive examinations were defined as positive imaging results leading to a cancer diagnosis, and true-negative examinations were those with negative or

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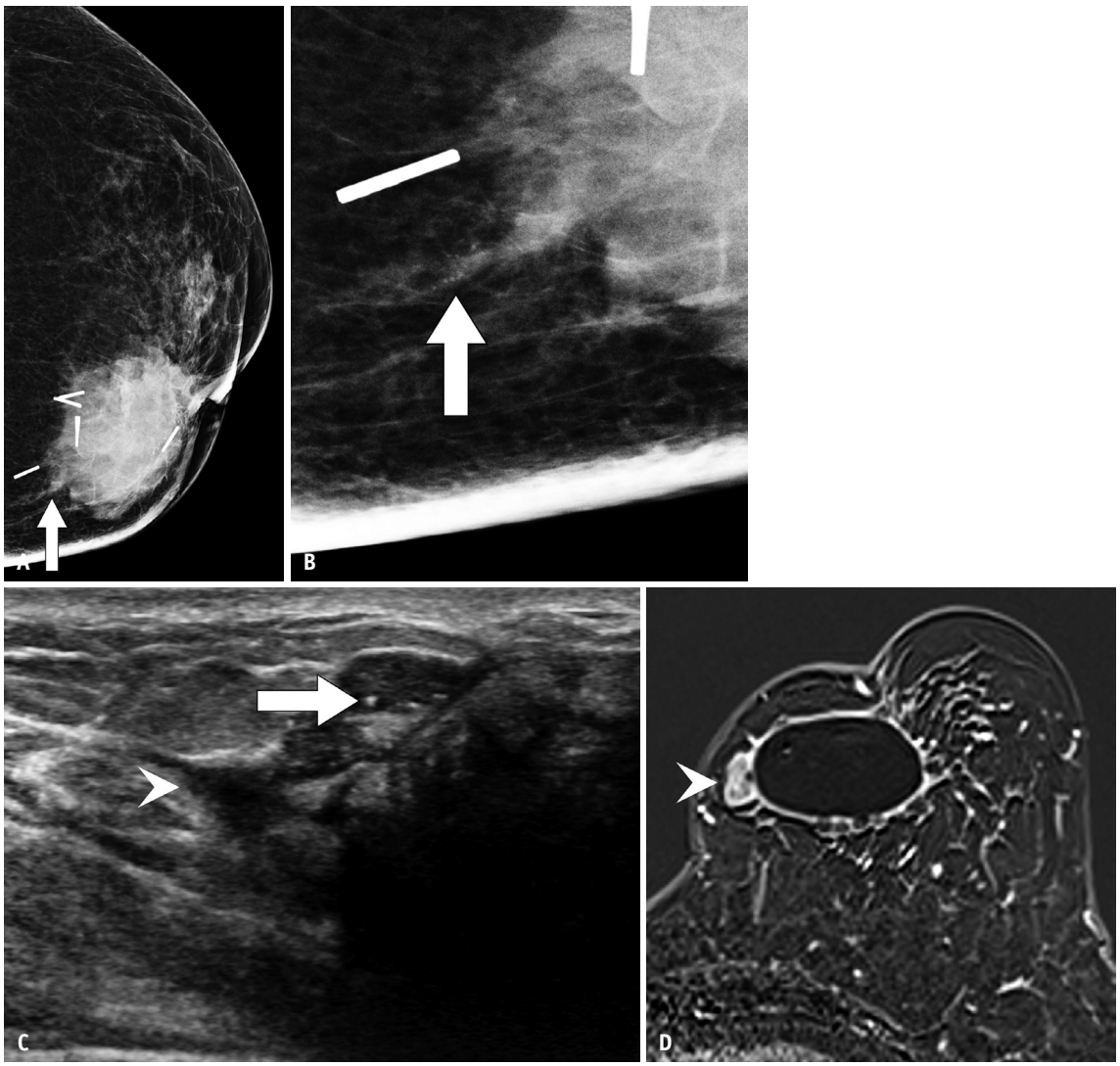


**Fig. 4.** A 61-year-old woman with recurrence in direct contact with MegaDerm® in postoperative surveillance 16 months after left breast-conserving surgery and pellet-type MegaDerm® insertion (Patient no. 9 in Table 3). **A, B:** Left craniocaudal view mammogram showed irregularities of MegaDerm®, with some of the irregularities accompanied by grouped amorphous calcifications (arrows). **(B)** is a zoomed-in image of **(A)**. **C:** Ultrasonography image showed irregularities of MegaDerm® (arrowhead) at the medial aspect of MegaDerm®, accompanied by suspected calcifications (arrow). **D:** T1-weighted contrast-enhanced fat-suppressed MRI image showed irregularities with enhancement of MegaDerm®, especially prominent at the medial side (arrowhead).

benign results. False-positive examinations were defined as those that led to recalls in women in whom no cancer was detected, and false-negative examinations were negative imaging results with a cancer diagnosis. Our reference standard was based on one-year follow-up imaging and pathology reports through biopsy and/or surgery. Recurrence times were calculated from the day of the first to the second surgery for recurrent cancer and expressed in months, rounded to the nearest whole number.

## RESULTS

### Imaging Findings of MegaDerm®

On MG, MegaDerm® appeared as a circumscribed mass with homogeneously iso- or high density. Postoperative calcifications often increased, usually seen within surgical beds with benign morphologies such as dystrophic calcifications. Table 1 presents the number of patients classified by calcification occurrence and type on the most recent MG. Calcifications occurred more commonly in sheet-type MegaDerm® than pellet-type (80.2% [97/121] vs. 60.0% [48/80], $P$ = 0.001). For sheet-type,


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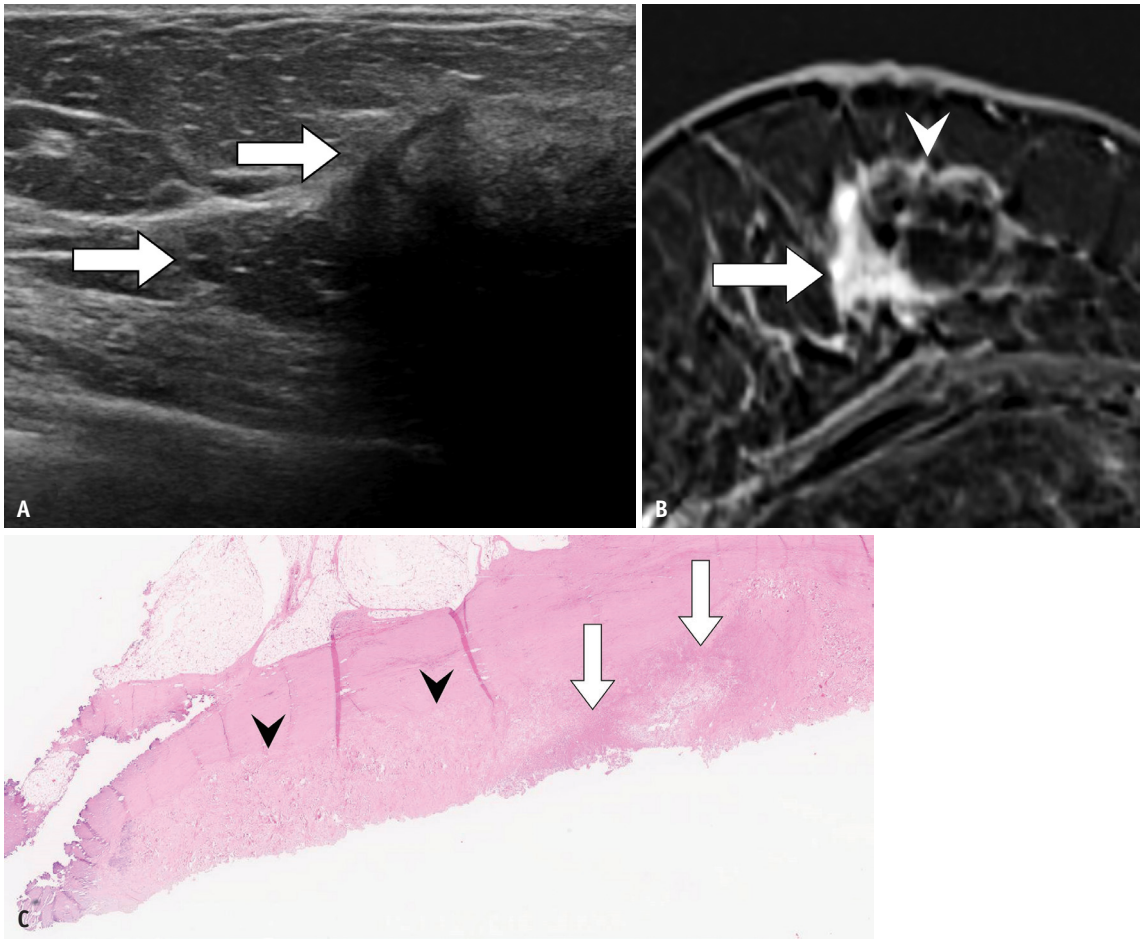


**Fig. 5.** A 56-year-old woman with false-positive in direct contact with MegaDerm® detected by US and MRI 59 months after right breast-conserving surgery and sheet-type MegaDerm® insertion (Patient no. 10 in Table 2). **A:** US image showed irregularities of MegaDerm® with echogenic halo (arrows) in the lateral aspect of MegaDerm®, and MegaDerm® exhibited posterior shadowing. **B:** T1-weighted contrast-enhanced fat-suppressed MRI image showed irregularity with enhancement (arrow) in the lateral aspect of MegaDerm® (arrowhead). Sheet-type MegaDerm® did not exhibit enhancement. US-guided biopsy was recommended to exclude recurrent cancer, and the lesion was confirmed as chronic inflammation. The patient was treated with antibiotics, but mastitis progressed gradually and total mastectomy was performed. **C:** After total mastectomy, a microscopic image revealed inflammation with necrosis (arrows) in direct contact with MegaDerm® implant (arrowheads). No cancer cell was shown (H&E stain, x1). US = ultrasonography

macro-calcifications were more common (77.3% [75/97]), whereas pellet-type, micro-calcifications were more frequent (89.6% [43/48]) ($P < 0.001$). Macro-calcifications in sheet-type MegaDerm® often demonstrated dystrophic calcifications along the sheets (Supplementary Fig. 3).

On US, sheet-type MegaDerm® appeared as a circumscribed and heterogeneous echoic mass, often with multiple isoechoic folded lines and a hypoechoic rim. Pellet-type MegaDerm® looked similar to sheet-type but was characterized by multiple small, isoechoic cuboid elements and sometimes demonstrated a relatively irregular margin (Fig. 3A). MegaDerm® always presented partial or complete posterior acoustic shadowing and fluid was sometimes present between the folds or cubes of MegaDerm®. On MRI, MegaDerm® revealed well-defined low-signal intensity on T2-weighted imaging and iso-signal intensity on T1-weighted imaging, without definite enhancement on the contrast-enhanced image. A T2-weighted image was useful for distinguishing inserted MegaDerm® types (Supplementary Figs. 4, 5).

### False Positives in Operative Bed

We identified 17 false-positive cases with suspicious imaging findings at the operative bed, including 15 sheet-type and two pellet-type MegaDerm® cases. These patients underwent US, MG, and MRI within one month. Eight of the 17 patients underwent biopsies to exclude recurrence. The remaining nine patients did not undergo biopsies, as


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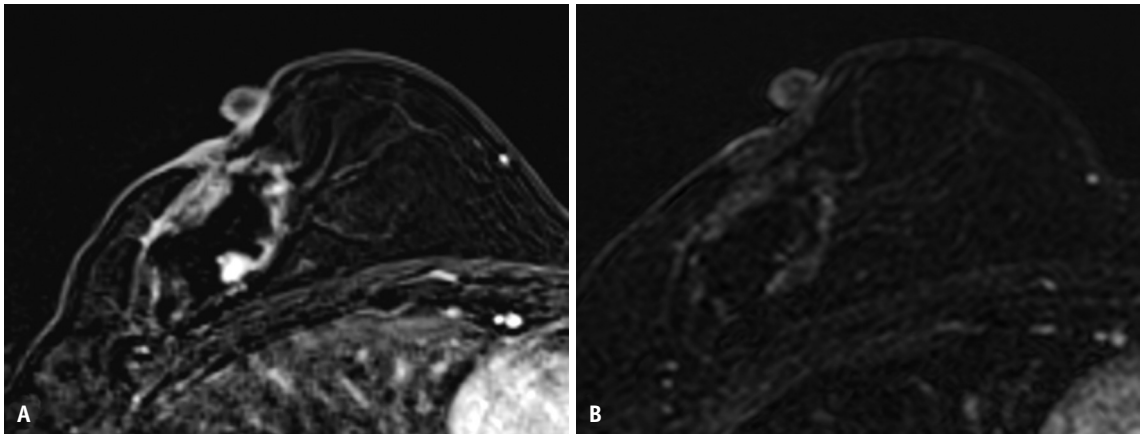


**Fig. 6.** A 53-year-old woman with a false positive in direct contact with MegaDerm® detected by MRI 36 months after left breast-conserving surgery and sheet-type MegaDerm® insertion (Patient no. 4 in Table 2). **A:** T1-weighted contrast-enhanced fat-suppressed MRI image showed irregularities with enhancement along MegaDerm®, with some nodular appearance, which was assessed as BI-RADS category 4A. Mammography and ultrasonography performed on the same day showed no suspicious findings (not shown), so short-term follow-up was recommended. **B:** After one year, a follow-up T1-weighted contrast-enhanced fat-suppressed MRI image showed the irregularities improved slightly and enhancement decreased (downgraded to BI-RADS category 3). One year after that, follow-up MRI images also showed further improvement (not shown). BI-RADS = Breast Imaging Reporting and Data System

**Table 1.** Calcification findings on mammography according to MegaDerm® type

| Calcification findings | Sheet-type | Pellet-type | *P* |
|---|---|---|---|
| Presence | | | 0.001 |
| Absent | 19.8 (24/121) | 40.0 (32/80) | |
| Present | 80.2 (97/121) | 60.0 (48/80) | |
| Type (for calcification-positive cases only) | | | <0.001 |
| Micro-calcification | 22.7 (22/97) | 89.6 (43/48) | |
| Macro-calcification | 77.3 (75/97) | 10.4 (5/48) | |

Data are presented as a percentage (n/n)

their suspicious findings were observed in only one or two imaging modalities and did not change or resolve on follow-up imaging.

Table 2 summarizes the suspicious imaging findings of false-positives in the operative bed. Among the 17 cases, nine showed suspicious findings in direct contact with MegaDerm® (marked with asterisks in Table 2). On MG, one case showed micro-calcification (Fig. 2A) and another showed the development of asymmetry and MegaDerm® irregularity. On US, four cases showed hypoechoic masses and one showed MegaDerm® irregularity (Fig. 5A). On MRI, four cases showed MegaDerm® irregularities with enhancement (Figs. 5B, 6A) and four showed enhancing masses, two of which also showed rim enhancement. Tissue biopsy confirmed inflammation in three patients with sheet-type MegaDerm®, two of whom presented with mastitis symptoms suspected to be related to ADM (Patients 10 and 15 in Table 2) (Fig. 5, Supplementary Fig. 1).

### Recurrences in Operative Bed

Among the study patients, nine out of 201 (4.5%) experienced recurrence in the operative bed. Supplementary Table 1 summarizes the characteristics of patients with recurrent breast cancer, including pathologic types such as invasive ductal carcinoma (n = 5), ductal carcinoma in situ (n = 2), invasive lobular carcinoma (n = 1), and mucinous carcinoma (n = 1). Molecular subtypes were the same for both initial and recurrent breast cancer and all had negative resection margins following the first surgery. The median follow-up length was 26 months, ranging from 13 to 71 months.

Table 3 summarizes suspicious imaging findings of recurrences in the operative bed. Among the nine cases, six showed suspicious findings in direct contact with MegaDerm® in all three imaging modalities (marked with asterisks in Table 3). On MG, the six cases showed development of asymmetries (n = 2), micro-calcifications (n = 2), MegaDerm® irregularity (n = 1), and MegaDerm® irregularity with micro-


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**Table 2.** Suspicious imaging findings associated with operative bed false-positives

| Mega Derm® type | Age (yr) | Follow-up time (mo) | Positive imaging modality | MG finding | US finding | MRI finding | Pathology result |
|---|---|---|---|---|---|---|---|
| Sheet | | | | | | | |
| 1* | 58 | 23 | MG | Calcification | Negative | Negative | NA† |
| 2 | 54 | 45 | US | Negative | Hypoechoic mass | Negative | Xanthogranulomatous inflammation |
| 3 | 35 | 64 | US | Negative | Hypoechoic mass | Negative | Sclerosing adenosis |
| 4* | 53 | 36 | MR | Negative | Negative | MegaDerm® irregularity with enhancement | NA† |
| 5* | 58 | 37 | MR | Negative | Negative | MegaDerm® irregularity with enhancement | NA† |
| 6 | 46 | 71 | MR | Negative | Negative | Non-mass enhancement | NA† |
| 7 | 63 | 52 | MR | Negative | Negative | Non-mass enhancement | NA† |
| 8 | 53 | 24 | MG/US | Developing asymmetry | Isoechoic parenchymal change | Negative | NA† |
| 9 | 48 | 53 | MG/MR | Developing asymmetry | Negative | Enhancing mass | NA† |
| 10* | 59 | 59 | US/MR | Negative | MegaDerm® irregularity | MegaDerm® irregularity with enhancement | Inflammation with necrosis |
| 11 | 63 | 41 | US/MR | Negative | Ductal dilatation | Non-mass enhancement | Fibrocystic disease |
| 12* | 72 | 50 | US/MR | Negative | Hypoechoic mass | Rim-enhancing mass | Inflammation with fat necrosis |
| 13* | 52 | 27 | US/MR | Negative | Hypoechoic mass | Enhancing mass | Sclerosing adenosis |
| 14* | 49 | 59 | US/MR | Negative | Hypoechoic mass | Enhancing focus | Stromal fibrosis |
| 15* | 57 | 72 | MG/US/MR | Developing asymmetry and MegaDerm® irregularity | Ill-defined hypoechoic mass | Rim-enhancing mass | Inflammation with fat necrosis |
| Pellet | | | | | | | |
| 16* | 67 | 19 | MR | Negative | Negative | MegaDerm® irregularity with enhancement | NA† |
| 17 | 28 | 6 | MR | Negative | Negative | Enhancing focus | NA† |

*Patient who showed suspicious imaging findings in direct contact with MegaDerm®, †No change or resolved on follow-up imaging.
MG = mammography, US = ultrasonography, NA = not applicable

**Table 3.** Suspicious imaging findings associated with operative bed recurrences

| Patient no. | MG | US | | MRI | |
|---|---|---|---|---|---|
| | MG finding | US finding | Vascularity | MRI finding | Delayed kinetics |
| 1* | Developing asymmetry | Mass | Absent | Rim-enhancing mass | Persistent |
| 2 | Developing asymmetry | Mass | Absent | Rim-enhancing mass | Washout |
| 3* | Micro-calcifications | Mass | Present | Irregularly shaped mass | Persistent |
| 4* | Micro-calcifications | Mass | Present | Rim-enhancing mass | Washout |
| 5 | Micro-calcifications | Mass with calcification | Present | Rim-enhancing mass | Persistent |
| 6* | MegaDerm® irregularity | MegaDerm® irregularity | Absent | MegaDerm® irregularity with enhancement | Persistent |
| 7 | Macro-calcifications† | Mass | Present | Linear non-mass enhancement and rim-enhancing mass | Persistent |
| 8* | Developing asymmetry | Mass | Present | Rim-enhancing mass | Washout |
| 9* | MegaDerm® irregularity with micro-calcification | MegaDerm® irregularity with calcifications | Present | MegaDerm® irregularity with enhancement | Persistent |

*Patient who showed suspicious imaging findings in direct contact with MegaDerm®, †The MG exhibited 'mixed-calcification,' but it was finally classified as a predominant type, macro-calcification.
MG = mammography, US = ultrasonography


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calcification (n = 1) (Fig. 4A, B). On US, they showed hypoechoic masses (n = 4) (Fig. 3A), MegaDerm® irregularity (n = 1), and MegaDerm® irregularity with calcification (n = 1) (Fig. 4C). On MRI, they showed rim-enhancing masses (n = 3) (Fig. 3B), MegaDerm® irregularities with enhancement (n = 2) (Fig. 4D), and irregular-shaped mass (n = 1). These findings closely paralleled those seen in false positives, except for MegaDerm® irregularity with micro-calcification observed in only one recurrence case. In two patients exhibiting MegaDerm® irregularities (Patients 6 and 9 in Table 3), pathologic results revealed recurrent cancer cells attached to the implanted MegaDerm®.

The diagnostic performances for detecting operative bed recurrent breast cancer using MG, US, and MRI are presented in Table 4. The sensitivity of recurrence detection was 100% for MG, US, and MRI for both sheet- (7/7) and pellet-type (2/2) MegaDerm®.

## DISCUSSION

This study analyzed how postoperative surveillance images after MegaDerm® insertion affected image interpretation according to the type of MegaDerm®. Calcifications were more common and increased in size more significantly in sheet-type MegaDerm® compared to pellet-type (Table 1). The calcification shape sometimes followed the MegaDerm® shape, depending on the type. Calcifications within the surgical bed may indicate tumor recurrence or postsurgical change [9,13]. However, only one case of suspicious calcifications, which was not a recurrence, was observed in this study, which also progressed to benign calcifications on follow-up examination (Fig. 2). This suggests that differentiating calcifications following MegaDerm® insertion is not difficult. Short-term follow-up surveillance may be more beneficial than an immediate biopsy when ambiguous micro-calcifications are detected [9,14].

On US, suspicious findings commonly appeared as masses in direct contact with MegaDerm®; however, new MegaDerm® irregularities were also detected. These irregularities may indicate the irregular borders of pellet-type MegaDerm®, possibly due to the margin of small diced cubes (Supplementary Fig. 2), and also indicate ADM-associated inflammations and recurrent cancers. No cases in this study showed posterior shadowing of MegaDerm® obscuring recurrence; however, the shadowing can hinder clear visualization beyond the MegaDerm®, complicating the evaluation of deep lesions. Therefore, careful evaluation of the MegaDerm® periphery is crucial. On MRI, since the inside of MegaDerm® does not show contrast enhancement, suspicious enhancements surrounding MegaDerm®, often accompanied by peripheral irregularity, can be detected. Although statistical comparisons are limited by the small number of cases, recurrences frequently appeared as masses, while false positives more often appeared as non-mass enhancements with no change or improvement on follow-up (Fig. 6).

Our study suggests that suspicious imaging findings in direct contact with MegaDerm® could indicate either false positives or recurrences. To minimize false positives and ensure timely recurrence detection, it is necessary to recognize suspicious findings and check the patient's history of MegaDerm® insertion. Furthermore, all recurrences in direct contact with MegaDerm® exhibited suspicious findings on all three imaging modalities (MG, US, and MRI), while only one false positive was suspicious on all three modalities. However, 44.4% (4/9) of false-positives in direct contact with MegaDerm® had no change or resolution of suspicious findings in follow-up images. These results indicate that multi-modality imaging surveillance and monitoring changes over time may be helpful.

Suspicious findings may represent inflammation if there

**Table 4.** Tallies of true positives, true negatives, false positives, and false negatives, and diagnostic performances of each imaging modality in recurrent breast cancer detection

| | MG (n = 713) | | US (n = 1063) | | MRI (n = 607) | |
|---|---|---|---|---|---|---|
| | Sheet type (n = 484) | Pellet type (n = 229) | Sheet type (n = 721) | Pellet type (n = 342) | Sheet type (n = 394) | Pellet type (n = 213) |
| True-positive, n | 7 | 2 | 7 | 2 | 7 | 2 |
| True-negative, n | 473 | 227 | 705 | 340 | 376 | 209 |
| False-positive, n | 4 | 0 | 9 | 0 | 11 | 2 |
| False-negative, n | 0 | 0 | 0 | 0 | 0 | 0 |
| Sensitivity, % | 100 (7/7) | 100 (2/2) | 100 (7/7) | 100 (2/2) | 100 (7/7) | 100 (2/2) |
| Specificity, % | 99.2 (473/477) | 100 (227/227) | 98.7 (705/714) | 100 (340/340) | 97.2 (376/387) | 99.1 (209/211) |

MG = mammography, US = ultrasonography


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are clinical symptoms of inflammation or inflammatory changes which are evident in images (Fig. 5). Sheet-type MegaDerm® demonstrated more overall false positives than pellet-type, with inflammation detected in half (4/8) of biopsied patients (Table 2). This result alignss with previous studies reporting fewer short-term complications with pellet-type ADM insertion [5,15]. As shown in Supplementary Figures 1 and 2, it might be because pellet-type MegaDerm® is flexible and fits easily into excision cavities, causing fewer inflammatory changes than sheet-type MegaDerm®, which is angled when folded and promotes inflammation [5].

Our study had several limitations. First, it was a retrospective study conducted at a single institution. Second, it was a preliminary study with few recurrences and did not perform all three imaging modalities simultaneously, limiting diagnostic performance evaluation. Third, sheet-type MegaDerm® was used first, followed by pellet-type, which limited accurate comparison of calcification progression between types. Finally, although we analyzed recurrences and false positives in direct contact with MegaDerm®, confirming whether MegaDerm® caused these findings is challenging. Therefore, more long-term, prospective, multi-center studies are needed to thoroughly assess the feasibility of each modality in postoperative surveillance after BCS with ADM reconstruction.

In conclusion, this study analyzed how two types of MegaDerm® are observed in postoperative surveillance images and how suspicious findings in direct contact with the inserted MegaDerm® appear. Suspicious imaging findings may be associated with false positives or recurrences, so it is crucial to recognize these characteristic findings and review the patient's history of MegaDerm® insertion if there is any doubt.

## Supplement

The Supplement is available with this article at https://doi.org/10.3348/kjr.2023.1073.

### Availability of Data and Material

The datasets generated or analyzed during the study are available from the corresponding author on reasonable request.

### Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

### Author Contributions

Conceptualization: Jin Chung, Da Won Jung. Data curation: Jin Chung, Da Won Jung. Formal analysis: Jin Chung, Jeoung Hyun Kim. Investigation: Jin Chung, Da Won Jung, Ji Min Kim. Methodology: Jin Chung, Da Won Jung. Project administration: Jin Chung. Software: Jin Chung, Da Won Jung. Supervision: Jin Chung, Eun Suk Cha, Ji Min Kim. Validation: Jeoung Hyun Kim. Formal analysis: Jin Chung, Jeoung Hyun Kim. Visualization: Eun Suk Cha. Writing—original draft: Jin Chung, Da Won Jung. Writing—review & editing: all authors.

### ORCID IDs

Da Won Jung
https://orcid.org/0000-0002-9452-1047
Jin Chung
https://orcid.org/0000-0001-9990-3768
Ji Min Kim
https://orcid.org/0000-0002-3846-8093
Eun Suk Cha
https://orcid.org/0000-0001-9588-2074
Jeoung Hyun Kim
https://orcid.org/0000-0003-3504-9595

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