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Pictorial essay – breast imaging on chest computed tomography after various types of breast surgery

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ABSTRACT

Introduction and aim. The incidence of breast cancer is increasing globally, prompting the development of various surgical and reconstructive techniques for treatment. Chest computed tomography (CT) is frequently performed for multiple clinical indications, including screening, postoperative surveillance, and staging. Therefore, this article aims to review and illustrate the characteristic imaging characteristics of various postoperative breast changes that may be incidentally identified on chest CT.

Material and methods. We reviewed the medical records of patients who underwent CT scans at our hospital in the past five years and had changes in the shape of their breasts to confirm diagnosis, surgery, or procedure name, etc.

Results. We compared CT findings of patients with surgically confirmed procedures with the surgical techniques to identify any deformities resulting from surgery. In addition, we investigated the indications and effects of each surgery.

Conclusion. Awareness of these characteristic CT appearances can help radiologists avoid misinterpretation, recognize complications or recurrence, and provide clinically relevant information even when breast findings are incidental.

Keywords. mammoplasty, mastectomy, postoperative breast

Introduction

Breast cancer is one of the most common malignancies and the second leading cause of cancer-related mortality worldwide.[1] As a result, various surgical treatment options have been developed, and breast reconstruction is frequently performed for aesthetic and psychological reasons after mastectomy or breast

conserving surgery. Consequently, the postoperative appearance of the breast can vary significantly, leading to a wide range of imaging findings. Therefore, radiologists to have a comprehensive understanding of these variations to ensure accurate interpretation.

In clinical practice, postoperative evaluation of patients with breast cancer is typically conducted using magnetic resonance imaging (MRI), mammography, and breast ultrasound. Chest computed tomography (CT), while primarily performed to evaluate for intrathoracic metastases, often incidentally includes the breasts within the field of view. Unlike dedicated breast imaging modalities, chest CT is not optimized for breast evaluation and is often interpreted without a focused assessment of postoperative breast anatomy. This creates a potential diagnostic blind spot in routine practice. In such cases, familiarity with the expected postoperative imaging findings is important for an accurate diagnosis (Fig. 1).

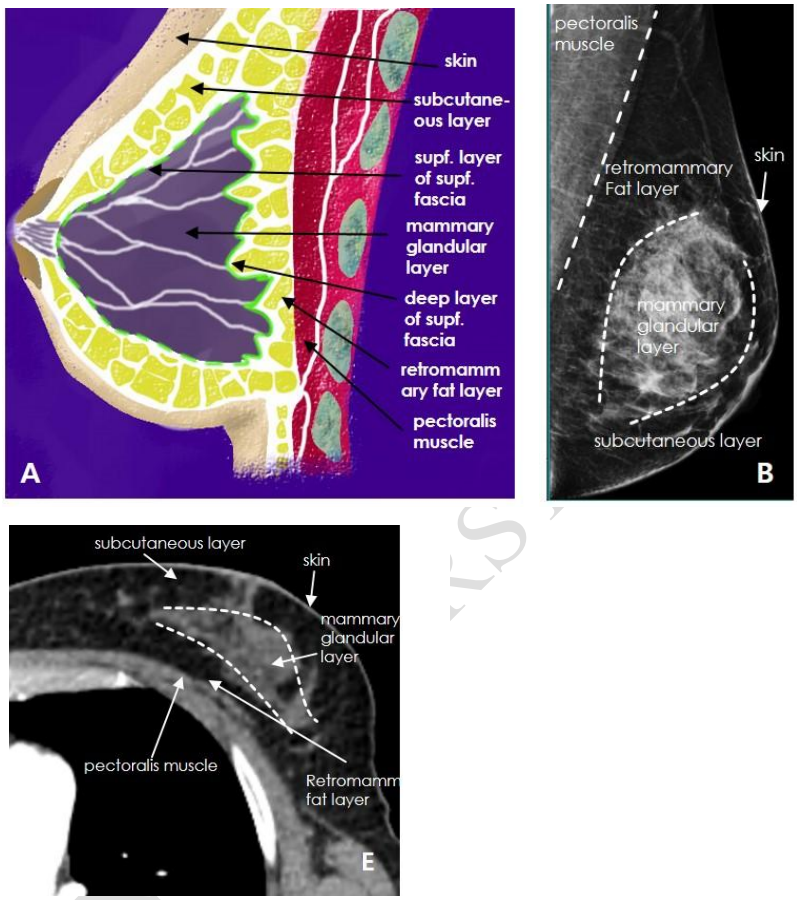

Fig. 1. A: Schematic diagram illustrating the anatomical structure of the breast, B: Mammography showing standard breast tissue without abnormalities, C: Breast ultrasound demonstrating the typical echogenicity of breast tissues, D: MRI of the breast, highlighting the detailed soft tissue contrast, E: Chest CT providing a cross-sectional view of the layers of the breast tissue (supf. Layer of supf. fascia superficial layer of superficial fascia, deep layer of supf. fascia deep layer of superficial fascia)

Furthermore, in patients undergoing chest CT for other indications, such as screening or evaluation of conditions such as pneumonia, postoperative breast changes may be the only imaging clue to a history of breast cancer surgery. Therefore, this pictorial essay focuses on the breast CT findings after surgical treatment for breast cancer (Table 1).

Table 1. Summary of figures with type of surgery*

Figure No.	Age	Diagnosis	Surgery type
3	36	Invasive ductal carcinoma	Modified radical mastectomy
4	65	Ductal carcinoma in situ	Breast conserving surgery
5	60	Invasive mucinous carcinoma	Modified radical mastectomy and augmentation mammoplasty
6	47	Cosmetic cause	Augmentation mammoplasty
7	58	Intraductal carcinoma (two site)	Modified radical mastectomy and TRAM flap
8	55	Invasive ductal carcinoma	Skin-sparing mastectomy and axillary dissection --> LD flap
9	63	Cosmetic cause	Injection mammoplasty (paraffin)

* TRAM transverse rectus abdominis myocutaneous, LD – lattisimus dorsi

Aim

The incidence of breast cancer is increasing globally, prompting the development of various surgical and reconstructive techniques for treatment. Chest CT is frequently performed for multiple clinical indications, including screening, postoperative surveillance, and staging. As a result, radiologists may encounter altered breast anatomy after surgery or reconstruction on chest CT reconstruction. Lack of familiarity with the postoperative appearance of the breast may lead to misinterpretation or missed diagnoses. Therefore, this article aims to review and illustrate the characteristic imaging characteristics of various postoperative breast changes that may be incidentally identified on chest CT.

Material and methods

We retrospectively reviewed CT scans of female patients who underwent contrast-enhanced chest CT in the past five years. Cases with breast abnormalities or bilateral asymptomatic breasts were also included. We reviewed the medical records of the included patients and, if the surgical procedure was available, we reviewed the literature to determine the surgical technique and compared it with the CT findings. If the reason for the surgery could be identified, the diagnosis was also recorded.

Results

Surgical treatment for removal of breast mass

Treatment options for breast cancer include surgery, radiation therapy, and chemotherapy. Among these, surgery is the primary treatment modality for operable breast cancer confined to the breast tissue and regional lymph nodes. Advances in breast imaging modalities such as mammography, ultrasound, and magnetic resonance imaging have facilitated earlier detection and led to significant evolution in surgical techniques. Tumor size reduction through early detection has expanded surgical options, including the introduction of skin-sparing and nipple-sparing mastectomies in recent years.

Breast surgery can generally be classified into two categories: mastectomy and breast preservation surgery, depending on whether residual breast tissue remains after surgery.[1,2]

Mastectomy

Mastectomy refers to the surgical removal of all breast tissue and is performed in various forms depending on the extent of tissue excision and oncologic considerations. This paper reviews five commonly performed types of mastectomy: radical mastectomy, simple (total) mastectomy, modified radical mastectomy, skin-sparing mastectomy, and nipple-sparing mastectomy (Fig. 2).

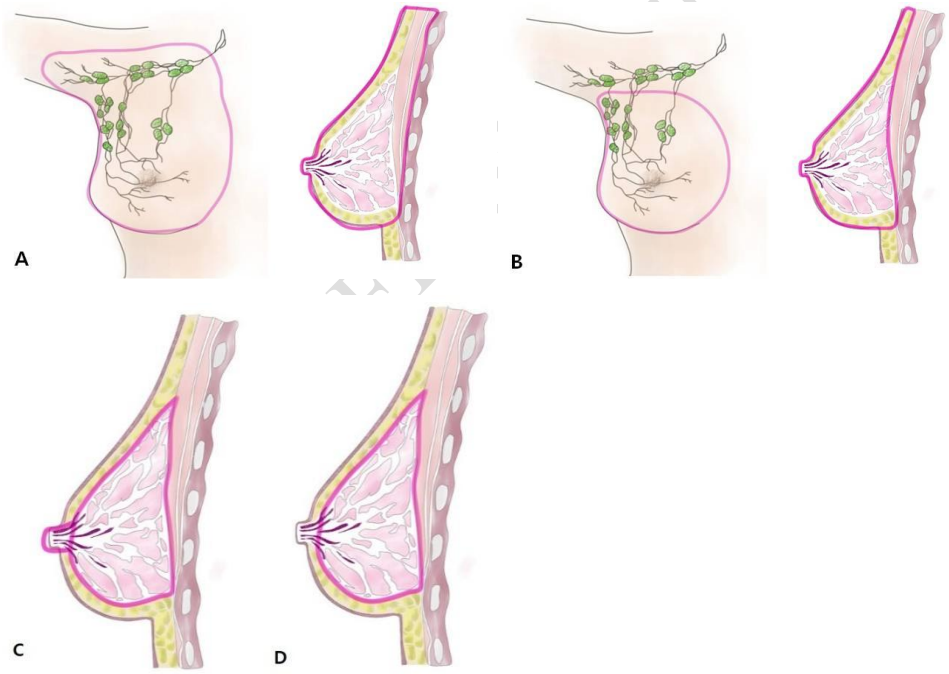

Fig. 2. A: Diagram showing radical mastectomy with a broad range of resection, including the pectoralis muscle, axillary lymph nodes, and adjacent veins in addition to the tissues removed in total mastectomy, B: Schematic image illustrating the extent of tissue removal in total mastectomy, in which breast tissue, skin, and nipple-areola complex are removed while preserving the pectoralis muscle, C: Schema of skin-sparing

mastectomy demonstrating removal of breast tissue while maintaining the overlying skin envelope; the nipple-areola complex is removed, D: Nipple-sparing mastectomy image depicting preservation of both the skin envelope and the nipple–areola complex, with removal limited to the underlying breast tissue, in all panels, bold red lines indicate the limits of tissue excision for each surgical procedure

Radical mastectomy

Radical mastectomy was the earliest standard surgical treatment for breast cancer. It involves the complete removal of all breast tissue, overlying skin, nipple-areolar complex (NAC), major and minor muscles, as well as axillary lymph nodes at levels I, II, and III, and sometimes the axillary vein. Although effective oncologically, this procedure is associated with significant cosmetic deformity and functional impairment and has largely been replaced by modified radical mastectomy.

On chest CT, radical mastectomy appears as a bare chest wall with absent breast parenchyma, pectoral muscles, skin and NAC. The axillary region may show the absence of regional lymph nodes and postoperative changes, such as thin subcutaneous fat directly overlying the chest wall musculature.

Simple (total) mastectomy and modified radical mastectomy

A simple (total) mastectomy involves removal of breast tissue, skin, and NAC while preserving the pectoralis muscles. A modified radical mastectomy includes all elements of a simple mastectomy, but also involves axillary lymph node dissection, typically levels I and II (Fig. 3).

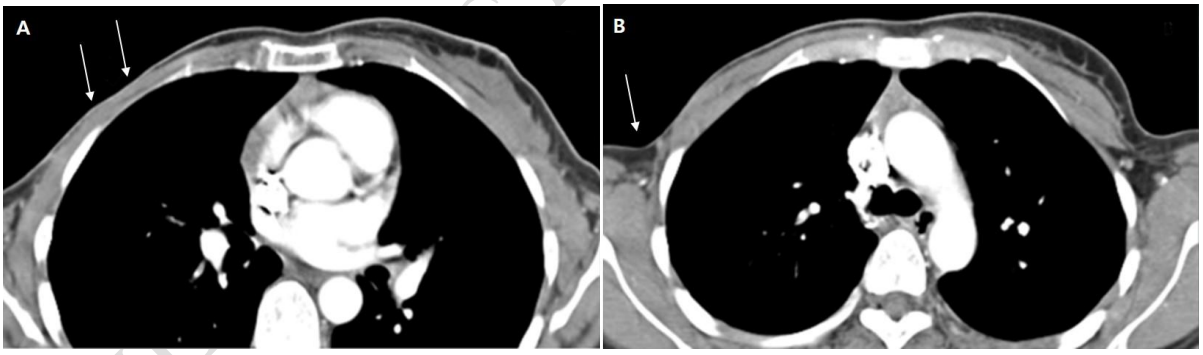

Fig. 3. A: Chest CT after modified radical mastectomy demonstrating removal of the right breast tissue, overlying skin and the nipple–areola complex, and remaining underlying pectoralis muscles, resulting in exposure of the bare chest wall (arrows), B: Chest CT showing absence of the right axillary lymph nodes after surgical dissection (arrow)

In both procedures, the major and minor muscles remain intact and are therefore visible on chest CT. In modified radical mastectomy, postoperative changes or scarring may be observed in the axillary region.

Furthermore, in most patients undergoing simple (total) mastectomy, a sentinel lymph node biopsy is performed to evaluate lymph node metastasis, which can also result on minor surgical scarring in the axilla.

Skin-sparing mastectomy

Skin-sparing mastectomy removes all of the breast tissue and NAC, while preserving the overlying skin envelope. Immediate breast reconstruction is typically performed to restore breast contour. This technique is commonly used in patients with T1–T2 breast cancer, ductal carcinoma in situ (DCIS), or for prophylactic mastectomy, but is contraindicated in cases of inflammatory breast cancer or skin involvement.[1,3]

On chest CT, the NAC and the underlying breast tissue are absent, while the native skin and subcutaneous fat remain intact. Depending on the reconstruction method, the images may show an autologous free flap, implants or tissue expanders placed beneath the preserved skin.

Nipple-sparing mastectomy

Nipple-sparing mastectomy is a modification of skin-sparing mastectomy that preserves the NAC in addition to the skin envelope. First described by Freeman in 1962, this technique was initially abandoned due to concerns regarding tumor safety and cosmetic outcomes. However, subsequent studies, including the 1999 report by Hartmann et al., demonstrated its efficacy in prophylactic mastectomy for high-risk patients and later in selected cases of breast cancer[4].

Classically, eligibility criteria included: tumor size <2.5 cm, tumor > 2 cm from the NAC. Clinically negative axillary lymph node. Absence of skin involvement or Paget's disease, and negative preoperative MRI for NAC invasion[4.]

Nipple-sparing mastectomy has quickly become a popular standard procedure, with recent retrospective studies demonstrating its oncological safety and cosmetic benefits. However, caution is advised in patients with nipple discharge, inflammatory breast cancer, or NAC -related symptoms.[4]

On chest CT, NAC and skin are preserved, with the absence of the underlying glandular tissue. In some cases, the NAC may also appear intact after other forms of mastectomy due to nipple reconstruction procedures.

Breast-conservation surgery

Breast conserving surgery involves the removal of the breast tissue that contains the tumor along with a margin of normal breast tissue, while preserving the overall contour and appearance of the breast. In patients with invasive ductal carcinoma, a sentinel lymph node biopsy is performed, and if there is evidence of lymph node involvement, an axillary lymph node dissection is performed. Compared to radical surgery, breast-conserving surgery offers superior cosmetic results. This procedure is performed most commonly in patients with T1 and T2 early-stage breast cancers.

Following breast preservation surgery, the majority patients undergo adjuvant radiation therapy and chemotherapy may be administered as indicated[1]. On chest CT, postoperative findings typically include partial removal of the breast tissue that encompasses the tumor with preservation of adjacent normal tissue. The presence of surgical clips and mild deformation of the breast contour often facilitate identification of the surgical procedure (Fig. 4). Furthermore, patients who have undergone radiation therapy may exhibit skin thickening or increased parenchymal trabecularity, which are typical post-radiation changes.

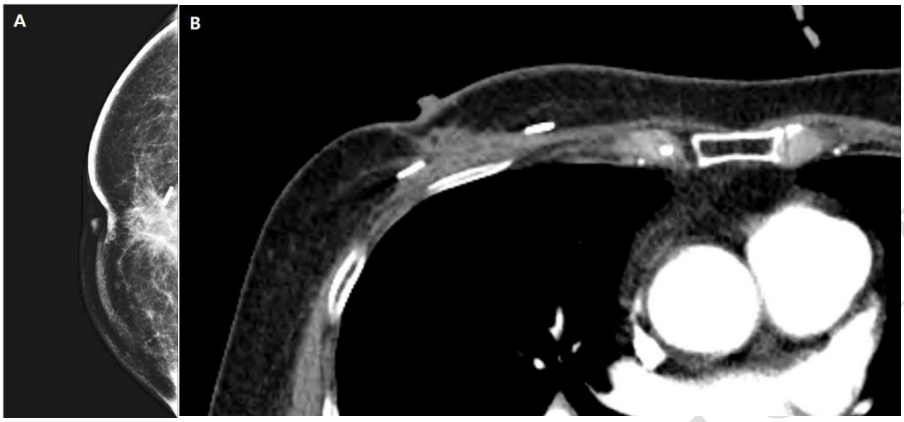

Fig. 4. A: Mammography showing postoperative changes in the right breast consistent with breast-conserving surgery, B: Chest CT showing resection of abnormal breast tissue in the right breast, with surgical clips visible at the operative site corresponding to the findings on mammography

Breast reconstruction

Breast reconstruction encompasses a range of techniques, including autologous flap reconstruction, implant-based reconstruction, NAC reconstruction, and, less commonly, liquid silicone or paraffin injections.

The choice of reconstruction method is influenced by multiple factors, such as the type of prior breast cancer surgery (eg mastectomy vs. breast-conserving surgery), the patient's body habitus, medical history, findings from physical examination and whether adjuvant radiotherapy has been performed.

From a practical perspective of CT interpretation, radiologists should systematically assess muscle sacrifice, donor-site alterations, characteristic reconstruction-specific landmarks, and visibility of the vascular pedicle visibility, while remaining aware of common diagnostic pitfalls, such as fat necrosis that may mimic tumor recurrence.

Breast implant

The use of breast implants has been increasing for various indications, including cosmetic augmentation, reconstruction after partial or total mastectomy, and correction of congenital breast deformities.

Implants can be classified on the number of lumens and the type of filler material.

There are two main types:

Single-lumen implants, which contain either silicone gel or saline solution.

Double-lumen implants, consisting of an inner and outer chamber. A standard double-lumen implant typically has a silicone-filled inner lumen and a saline-filled outer lumen. Conversely, a reverse double-lumen implant contains saline in the inner lumen and silicone gel in the outer lumen.

Breast implants are most commonly placed either in the subglandular space (beneath the breast tissue) or in the submuscular space (subpectoral) (beneath the pectoralis major muscle). Following implantation, the body forms a fibrous capsule around the implant in response to foreign material – a process known as encapsulation.[6]

On mammography, silicone appears as a dense radiopaque mass due to its relatively low radiolucency. On ultrasound, implants appear as anechoic spaces surrounded by echogenic boundaries, representing the elastomeric shell and fibrous capsule. One or two discrete echogenic lines may be seen that correspond to the implant wall and the surrounding capsule. On chest CT, silicone implants are easily identified as oval-shaped structures with soft tissue-like attenuation, distinguishable in either the subglandular or subpectoral locations. Single-lumen silicone-filled implants appear homogeneous with a well-defined elastomeric shell, often visible as a high-density rim (Fig. 5).

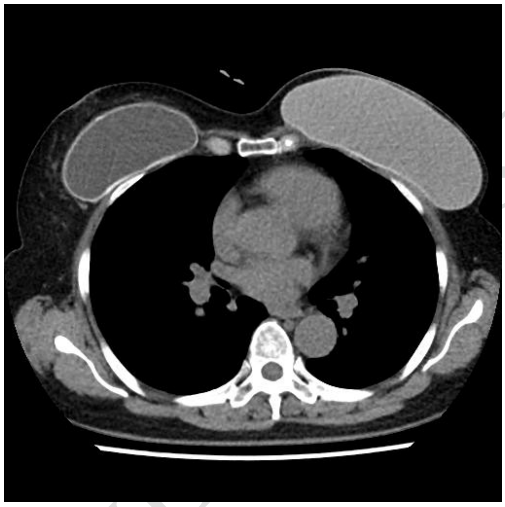

Fig. 5. Chest CT showing normally positioned mammoplasty implants in the subareolar region of both breasts, the right breast implant shows water-like attenuation, suggesting a saline-filled bag, while the left breast implant demonstrates relatively higher attenuation, presumed to represent a silicone-filled bag

In double-lumen reverse implants, the inner lumen filled with saline demonstrates fluid attenuation, while the outer lumen filled with silicone shows soft tissue attenuation, similar to single-lumen silicone implants. Radial folds and small volumes of periprosthetic fluid may sometimes be observed in asymptomatic implants and should not be misinterpreted as signs of rupture. This fluid is thought to represent a benign

inflammatory response. Over time, capsular thickening or calcification may occur and can be readily detected on CT.

Implant rupture

Breast implants are not permanent devices and are subject to rupture over time, and the risk increasing with implant age. Most ruptures occur 10 to 15 years after placement, although the exact incidence remains unclear.[7]

Ruptures are typically classified as intracapsular or extracapsular:

Intracapsular rupture occurs when the implant shell is damaged, but the contents (silicone or saline) remain confined within the fibrous capsule (Fig. 6).[8] This type of rupture is more common and may be difficult to detect on mammography, although subtle contour deformities or focal bulging of the implant may be observed.

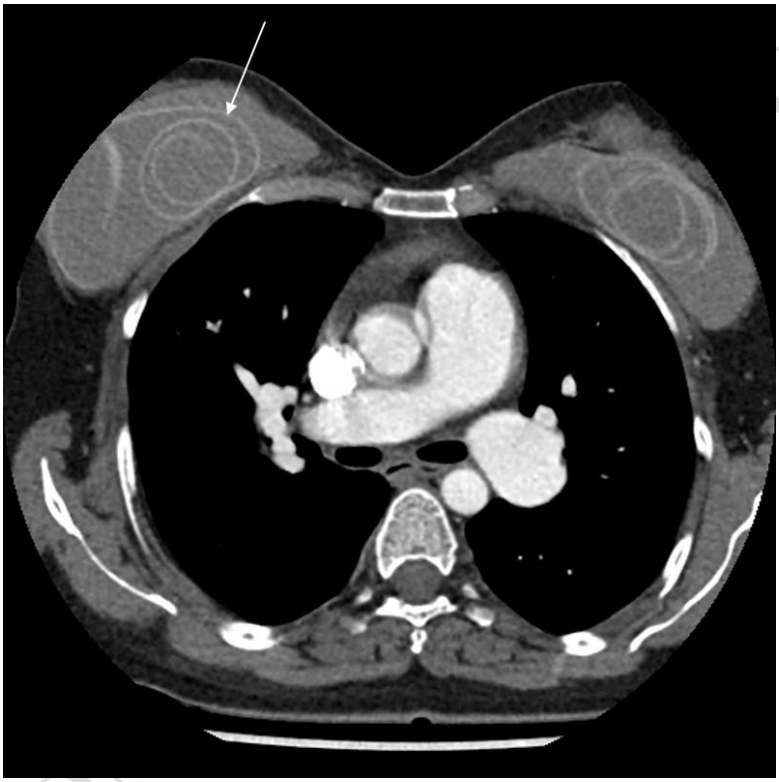

Fig. 6. Chest CT demonstrating intracapsular rupture of both breast implants, multiple linear structures parallel to the implant capsule (arrow), consistent with the 'linguine sign', while the implant contents remain contained within the surrounding fibrous capsule without extracapsular leakage

In ultrasound, multiple echogenic lines within the capsule (representing collapsed shell fragments) create the characteristic 'stepladder sign.'

On MRI, low-signal-intensity curvilinear lines within the implant represent the 'linguine sign,' a hallmark of intracapsular rupture.

On chest CT, a deformed or retracted contour of the implant may be noted, indicating shell collapse.

Extracapsular rupture involves disruption of both the implant shell and the fibrous capsule, allowing silicone to escape into the surrounding breast tissue.

On mammography, extracapsular silicone may appear as radiolucent areas outside the implant boundaries.

Breast ultrasound demonstrates the 'snowstorm sign,' in which echogenic silicone droplets cause diffuse acoustic shadowing, obscuring normal tissue planes.

Magnetic resonance imaging and computed tomography can also detect extravasated silicone, particularly in the subcutaneous tissue or lymph nodes.

Flap surgery

After mastectomy, breast reconstruction can be performed using autologous tissue flaps - comprising skin and subcutaneous fat – as an alternative or complement to implant-based reconstruction. This approach is associated with superior long-term aesthetic and functional outcomes, as it can replace a substantial volume of breast tissue and more closely mimic the natural contour and texture.

Commonly used autologous flap techniques include the transverse rectus abdominis myocutaneous flap (TRAM), the deep inferior epigastric perforator flap (DIEP), the latissimus dorsi flap, and the profunda artery perforator flap (PAP).

The TRAM flap involves the transposition of the transverse rectus abdominis muscle and the overlying skin/subcutaneous tissue to the chest wall, typically through a subcutaneous tunnel. The pedicled TRAM flap includes a large part of the rectus abdominis muscle and is supplied by the superior epigastric vessels. Variants include the free TRAM flap and the muscle-sparing free TRAM flap, both of which aim to minimize donor site morbidity. However, mobilizing a significant portion of the rectus abdominis may weaken the abdominal wall and increase the risk of hernia formation.

On chest CT, the TRAM flap appears as a thin curvilinear soft tissue band within the reconstructed breast, corresponding to the autologous dermal layer (Fig. 7). Fat-attenuation tissue superficial to this band represents native subcutaneous chest fat, while deeper fat-attenuation tissue reflects transposed abdominal fat. In the presence of infection, inflammation, or tumor recurrence, this band may appear abnormally thickened, which warrants careful interpretation by radiologists.[10]

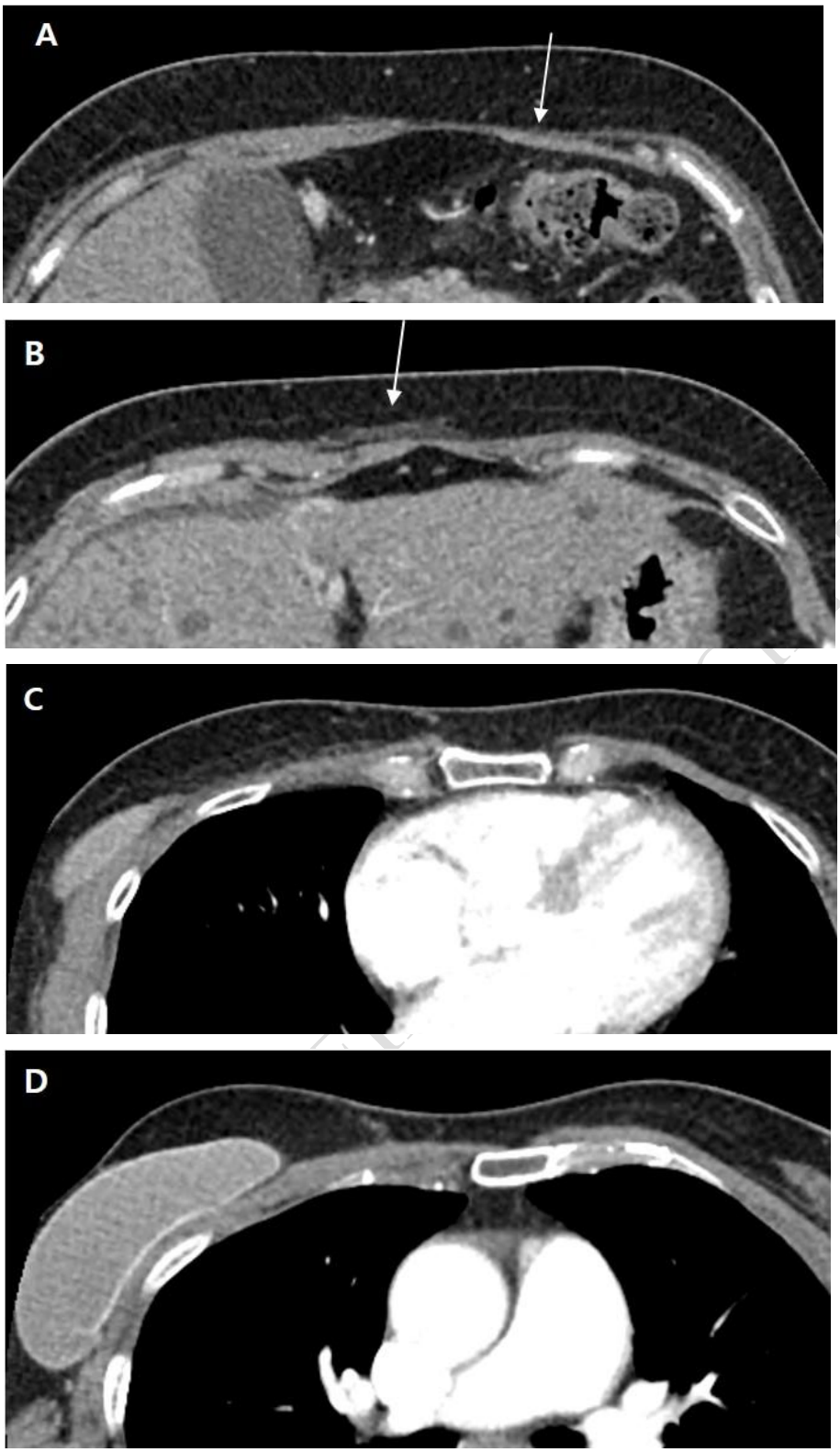

Fig. 7. A: Chest CT acquired in a caudocranial direction demonstrating absence of the left rectus abdominis muscle (arrow), indicating its use as a donor site for the TRAM flap, B: Image showing the pedicle (arrow) connecting the abdominal donor site to the reconstructed right breast, C: Chest CT depicting the formation of the right breast mound by the transferred TRAM flap tissue, D: Additional image showing a

mammoplasty bag used concurrently as a volume expander

The DIEP flap utilizes only skin and fat from the lower abdomen, preserving the rectus abdominis muscle. This muscle-sparing technique significantly reduces complications related to abdominal wall weakness such as hernias – while maintaining a natural breast shape and feel. The DIEP flap currently represents the most commonly performed autologous flap procedure in breast reconstruction. Successful harvesting requires precise microvascular dissection to isolate perforator vessels while sparing muscle.

The latissimus dorsi flap involves the transfer of skin, fat, and the latissimus dorsi muscle from the back to the chest wall (Fig. 8). Due to its proximity to the breast and its reliable vascularity, it is often used for partial reconstructions or in combination with implants when additional volume is needed. However, due to the relatively limited adipose tissue in the back, its utility for large-volume reconstructions is limited.

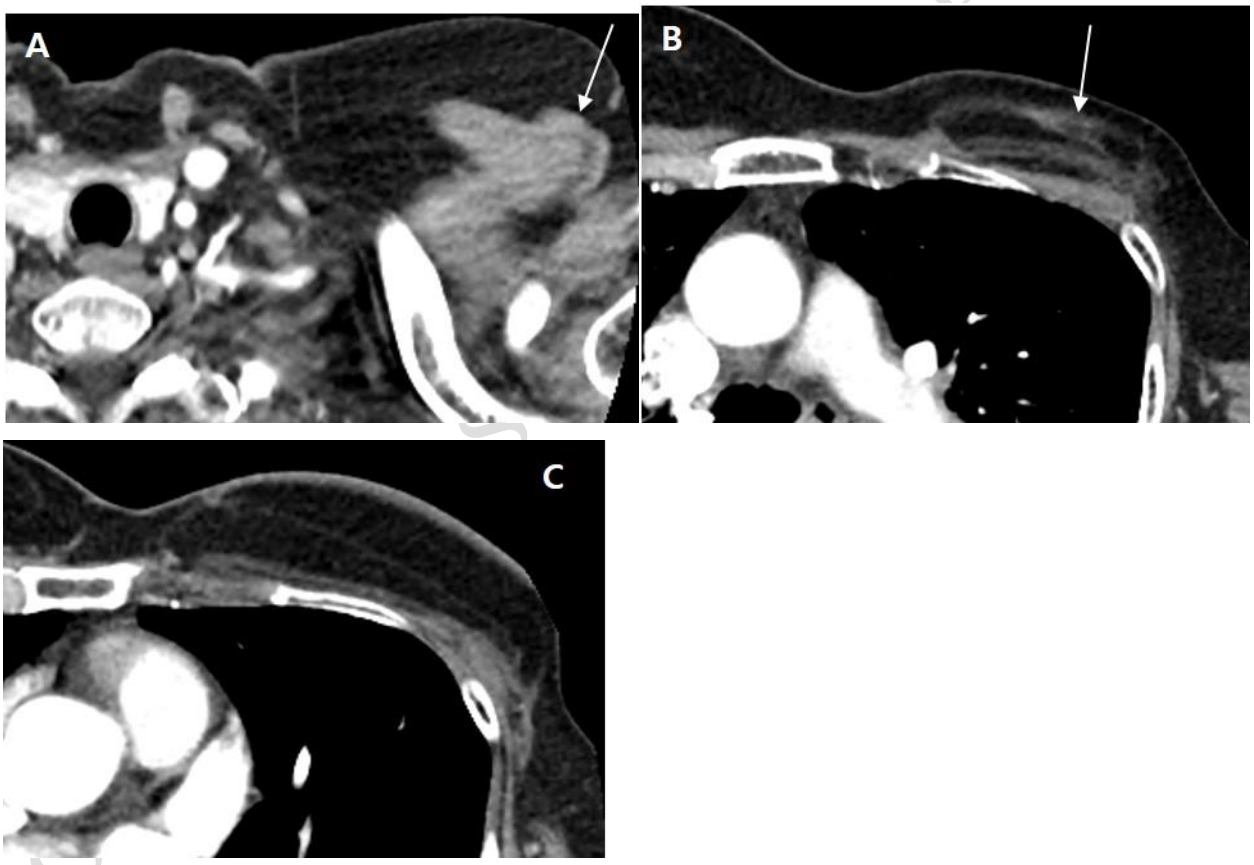

Fig. 8. A: Chest CT showing the pedicle (arrow) originating from the upper left chest, extending anterior to the humerus, B: Sequential image showing the pedicle descending toward the thoracic wall, C: Chest CT showing the transferred latissimus dorsi flap forming fatty tissue within the left breast region, contributing to the maintenance of the reconstructed breast contour

Direct injection of liquid silicone or paraffin

Although no longer commonly practiced, direct injection of liquid silicone or paraffin into breast tissue for cosmetic augmentation was performed between the early 1900s and 1970s. Since then, these procedures have been abandoned due to their serious long-term complications, including granulomatous inflammation, mass formation, fibrosis, and calcification of the breast parenchyma.

Silicone injections were used more frequently than paraffin and are associated with the development of silicone granulomas, which may appear on breast imaging and chest CT as multiple round high-density cystic lesions with eggshell calcifications. These findings often help delineate abnormal tissue within the breast parenchyma.[9]

On the contrary, paraffin granulomas are usually present as nodules of varying sizes, often with central radiolucency and calcification (Fig. 9). They may induce fibrotic reactions in the surrounding tissue, leading to blurring of the subcutaneous fat plane, skin thickening, and parenchymal calcifications.[11]

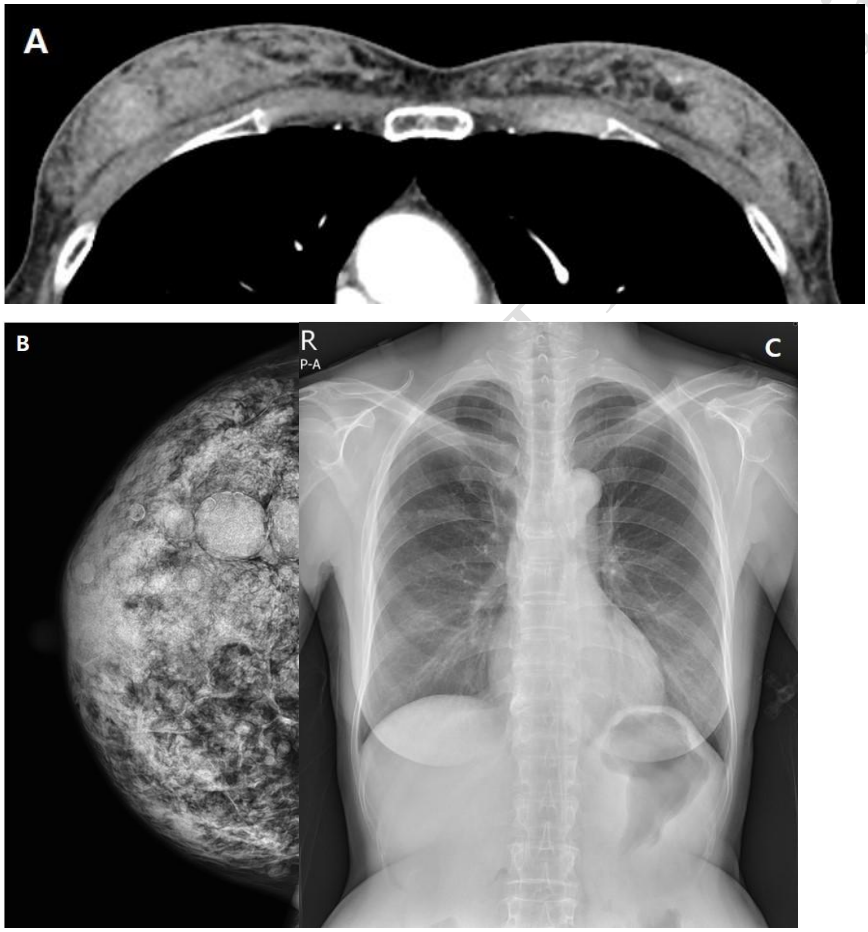

Fig. 9. A: Chest CT demonstrating a mild increase in opacity in both breasts. Some areas show small round calcifications, whereas extensive calcification is rare, B: Mammography showing multiple granulomas corresponding to areas of increased opacity on CT, consistent with paraffin granuloma. The absence of 'eggshell' calcification helps distinguish it from silicone granuloma, C: Chest PA showing no obvious

abnormalities in the breasts despite the presence of granulomas on CT and mammography

In cases where silicone and paraffin injections were used and if the granulomatous reaction progresses to extensive fibrosis with architectural distortion of the breast, breast cancer should be included in the differential diagnosis.[9] These post-injection changes represent one of the most challenging differential diagnoses on CT, as extensive fibrosis and calcifications can obscure or mimic underlying malignancy. Accurate imaging interpretation is essential, as post-injection changes can mimic or obscure the malignancy.

Conclusion

Chest CT may be performed in patients with breast cancer for a variety of postoperative indications, including surveillance, evaluation of complications, or unrelated clinical concerns. Given the wide range of surgical techniques and reconstructive procedures, as well as potential postoperative complications, it is essential for radiologists must accurately interpret chest CT findings in this context. Therefore, the systematic evaluation of the breasts on routine chest CT should be considered an integral component of comprehensive radiologic interpretation in patients with postoperative breast cancer.

Declarations

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Authors' contributions

Conceptualization, MJ.K.; Methodology, MJ.K.; Software, T.K.; Validation, MJ.K. and T.K.; Formal Analysis, T.K.; Investigation, T.K.; Resources, MJ.K.; Data Curation, MJ.K.; Writing – Original Draft Preparation, T.K.; Writing – Review & Editing, MJ.K.; Visualization, T.K.; Supervision, MJ.K.; Project Administration, MJ.K.

Conflicts of interest

All authors declare no conflict of interest.

Data availability

The data that support the findings of this study are available from the authors.

Ethics approval

The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Inje University Sanggye Paik Hospital (2025-08-010). All images are fully anonymized and do not contain any identifiable patient data. Therefore, patient consent and ethical approval were not required according to institutional policy.

References

1. Neal CH, Yilmaz ZN, Noroozian M, et al. Imaging of breast cancer-related changes after surgical therapy. *AJR Am J Roentgenol*. 2014;202(2):262-272. doi:10.2214/AJR.13.11517
2. Margolis NE, Morley C, Lotfi P, et al. Update on imaging of the postsurgical breast. *Radiographics*. 2014;34(3):642-660. doi:10.1148/rg.343135059
3. Ho CM, Mak CK, Lau Y, Cheung WY, Chan MC, Hung WK. Skin involvement in invasive breast carcinoma: safety of skin-sparing mastectomy. *Ann Surg Oncol*. 2003;10(2):102-107. doi:10.1245/aso.2003.05.001
4. Ashikari AY, Kelemen PR, Tastan B, Salzberg CA, Ashikari RH. Nipple sparing mastectomy techniques: a literature review and an inframammary technique. *Gland Surg*. 2018;7(3):273-287. doi:10.21037/gs.2017.09.02
5. Jung JI, Kim HH, Park SH, et al. Thoracic manifestations of breast cancer and its therapy. *Radiographics*. 2004;24(5):1269-1285. doi:10.1148/rg.245035062
6. Yang N, Muradali D. The augmented breast: a pictorial review of the abnormal and unusual. *AJR Am J Roentgenol*. 2011;196(4):W451-W460. doi:10.2214/AJR.10.4864
7. Juanpere S, Perez E, Huc O, Motos N, Pont J, Pedraza S. Imaging of breast implants-a pictorial review. *Insights Imaging*. 2011;2(6):653-670. doi:10.1007/s13244-011-0122-3
8. Brown SL, Middleton MS, Berg WA, Soo MS, Pennello G. Prevalence of rupture of silicone gel breast implants revealed on MR imaging in a population of women in Birmingham, Alabama. *AJR Am J Roentgenol*. 2000;175(4):1057-1064. doi:10.2214/ajr.175.4.1751057
9. Pinel-Giroux FM, El Khoury MM, Trop I, Bernier C, David J, Lalonde L. Breast reconstruction: review of surgical methods and spectrum of imaging findings. *Radiographics*. 2013;33(2):435-453. doi:10.1148/rg.332125108
10. LePage MA, Kazerooni EA, Helvie MA, Wilkins EG. Breast reconstruction with TRAM flaps: normal and abnormal appearances at CT. *Radiographics*. 1999;19(6):1593-1603. doi:10.1148/radiographics.19.6.g99no111593
11. Erguvan-Dogan B, Yang WT. Direct injection of paraffin into the breast: mammographic, sonographic, and MRI features of early complications. *AJR Am J Roentgenol*. 2006;186(3):888-894. doi:10.2214/AJR.05.0064