

Breast siliconoma diagnostic imaging challenges and recommendations: a case series

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Breast Siliconoma Diagnostic Imaging Challenges & Recommendations:**a case series**

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Breast Siliconoma Diagnostic Imaging Challenges & Recommendations: a case series**Abstract:**

Background: Free liquid silicone injection (FLSI) cases are still sporadically encountered despite advances in breast augmentation techniques. The American College of Radiology (ACR) guidelines support the use of breast magnetic resonance imaging (MRI) for silicone complication mapping in conventional medical-grade implant cases. However, FLSI-related complications remain lesser-known in clinical practice. A limited familiarity with their imaging appearances hinders accurate image interpretation and timely clinical management. This case series illustrates uncommonly reported multimodal imaging variations of siliconomas with histopathologic correlation.

Case Presentation: Two 56-year-old women (one Malay and one Chinese) with histories of FLSI presented with a unilateral breast lump and nipple discharge, respectively. Both patients underwent mammography, ultrasonography and MRI. Mammography showed innumerable siliconomas, potentially obscuring malignant lesions. In both cases, ultrasonography had limited diagnostic value. Dynamic contrast-enhanced MRI provided superior visualization but remained challenging to interpret due to the multiplicity of lesions and overlapping imaging features between benign silicone-related complications and malignancy. Both patients had uneventful surgeries, and histopathology confirmed the final diagnoses.

Conclusion: This case series is a preliminary step toward larger longitudinal cohort studies, aimed at characterizing the full spectrum of FLSI imaging appearances. Improved understanding can reduce diagnostic uncertainty where silicone-related changes obscure or mimic malignancy. The case findings also highlight the need for standardized, evidence-based, FLSI-specific imaging protocols and clinical guidelines to support informed decision-making and optimize patient care.

Keywords: Silicone gels, Subcutaneous injections, Breast implants, Foreign body granuloma, Mammography, Ultrasonography, Magnetic resonance imaging, Case series

Background

Rare cases of free liquid silicone injections (FLSIs), often performed by unauthorized practitioners, continue to be referred to radiology departments for screening or diagnostic evaluation. A direct causal relationship between silicone and breast cancer has yet to be established [1]. Nevertheless, clinicians need to be aware of the wide breadth of FLSI-related complications and associated imaging features, caused by foreign body and fibrotic reactions that mimic or mask malignancy.

Adverse effects of FLSI, influenced by substance purity, injection volume and depth, can occur immediately or after an asymptomatic period ranging from one month to 24 years [2]. Lipogranulomatosis, siliconomas and abundant fibrosis result in lumpy, hardened breasts [3-4] Other local complications include hyperpigmentation, peau d'orange, skin ulceration, fistula formation, necrosis and mastitis [2, 4-5].

Distant complications have also been reported, including silicone migration to other organs, lymphatic spread into the axillae and hematogenous dissemination, leading to silicone embolus syndrome [2, 4, 6]. Systemic associations described in literature include allergic reactions and autoimmune conditions such as systemic sclerosis, collagen vascular disease, vasculitis, eosinophilic fasciitis, polymyalgia rheumatic and polyarthritis [2, 6].

The American College of Radiology (ACR) recommends breast magnetic resonance imaging (MRI) for high-risk screening, preoperative staging, monitoring neoadjuvant chemoresponse, resolving equivocal imaging findings and mapping medical-grade implant complications [7]. MRI sensitivity

for breast cancer detection, including multifocal and multicentric disease, is reported to be approximately 91%, but is low in specificity i.e. 37% [3]. However, large-scale data on MRI performance specifically for FLSI cases, are lacking. There are currently no imaging protocols or interpretation guidelines specific for FLSI cases.

These two cases illustrate the variable multimodal appearances of siliconomas with histopathologic correlation. We highlight diagnostic challenges faced when MRI-compatible biopsy equipment was unavailable. By integrating our clinical experience with current literature, this case series provides insights to mitigate diagnostic ambiguity in complex FLSI cases.

Case presentation

This retrospective, observational case series included two consecutive patients with histories of FLSI, referred for breast imaging between January 2023 and December 2024. The first patient was a 56-year-old Malay woman who presented with a stable right breast lump over one year. The second patient was a 56-year-old Chinese woman who presented with intermittent blood-stained right nipple discharge over the preceding month. Patients with conventional breast implants were excluded.

Imaging for both patients included two-view digital mammography with tomosynthesis (Hologic 3D Dimensions™ System), high-resolution sonography using an 18.5-MHz linear array transducer (Hologic SuperSonic MACH 20) and dynamic contrast-enhanced MRI (1.5-T, Siemens, Erlangen, Germany) with a dedicated phased-array surface coil. As per institutional protocol, a power injector was used to administer 0.1 mmol/kg of gadolinium at a flow rate of 2 mL/s, followed by a 20 mL saline flush.

The institutional MRI protocol comprised axial T₁-weighted imaging (T1WI), fat-suppressed T₂-weighted imaging (T2WI FS), Turbo Inversion Recovery Magnitude (TIRM), diffusion-weighted imaging with apparent diffusion coefficient mapping (DWI/ADC), pre- and post-contrast fat-suppressed T₁-weighted imaging (T1WI FS & T1CE FS) sequences. Silicone-specific and water-suppression sequences were acquired in both axial and sagittal planes. Images interpretation was performed by a general radiologist with eight years of experience and reviewed by subspecialist breast radiologists for diagnostic consensus.

Key clinical presentations, imaging findings, differential diagnoses, BI-RADS assessments, managements, outcomes and relative timelines for both patients are summarized in Table 1. Images are illustrated in Figures 1-2 for the first patient and Figures 3-4 for the second patient.

Table 1: Summary of patient demographics, clinical presentations, imaging findings, management, histopathology, outcomes and timelines.

Case/Patient Number	1	2
Age	56	56
Biological Sex	Female	Female
Comorbidities	Hypertension, dyslipidemia Oligodendrioglioma under oncology	None reported
Family History	None reported	Mother had hysterectomy performed but was unsure of cause
Personal or family history of breast cancer	None reported	None reported
History of breast fillers	More than 10 years prior	More than 30 years prior
Previous breast surgery	None reported	None reported
Presenting symptoms	Painless right breast lump, stable in size	Recurrent blood-stained discharge in the right nipple
Onset of symptoms	1 year prior	1 month prior
Clinical examination	RLOQ palpable lesion, approximately 2 x 1 cm. No palpable axillary lymph nodes bilaterally.	Clear discharge at time of examination. No palpable breast lesions or axillary lymph nodes bilaterally.

Mammogram (MMG)	Fig. 1	Fig. 3
Breast density	Extremely dense (BI-RADS d)	Heterogeneously dense (BI-RADS c)
Architectural distortion	No bilaterally	No bilaterally
Asymmetric density	No bilaterally	Right retroareolar asymmetric density extending to all quadrants.
Mass-like lesions	Innumerable, randomly distributed round lesions; equal- and high-densities, some with peripheral rim calcifications.	Innumerable, randomly distributed round lesions; equal- and high densities, some with peripheral rim calcifications
Ultrasound (USG)	Fig. 1	Fig. 3
	Multiple superficial cystic globular lesions in both breasts and axillae; associated posterior acoustic shadowing obscuring deeper structures.	Multiple superficial cystic globular lesions in both breasts and axillae; associated posterior acoustic shadowing obscuring deeper structures.
Dynamic Contrast Enhanced Magnetic Resonance Imaging (MRI)	Fig. 2	Fig. 4
	Heterogenous fibroglandular tissue with symmetrical, moderate background enhancement.	Heterogenous fibroglandular tissue with symmetrical minimal background enhancement.
	Innumerable high T2WI/TIRM and low T1WI signal globules (0.2-0.9 cm) in keeping with free-filler augmentation within fibroglandular tissues, subcutaneous tissue, pectoralis and lymph nodes.	Innumerable high T2WI/TIRM and low T1WI signal globules (0.3-0.7 cm) in keeping with free-filler augmentation within fibroglandular tissues, subcutaneous tissue, pectoralis and lymph nodes.
	Few circumscribed round foci (≤ 0.5 cm) and masses (0.5-0.9 cm) in both breasts with internal and rim enhancements. One RLOQ enhancing lesion (Size: 0.8 x 0.7 x 0.9 cm) with TIC Type III enhancement pattern (contrast uptake and washout) seen. Bilateral sub-glandular fibrotic masses.	Clustered ring non-mass enhancement involving the RLOQ, RLIQ and right nipple areolar complex. Area: 9.4 x 11.4 x 6.5 cm (AP x W x CC)
	Follow-up MRI demonstrated mostly similar findings, with new foci and few resolved foci. The indeterminate RLOQ lesion had unchanged MRI enhancement characteristics, size and morphology.	TIC Type I & II: Moderate progressive increasing enhancements
Imaging differential diagnosis	Bilateral granulomatous mastitis with siliconomas. RLOQ lesion - Unable to exclude malignancy	Right segmental NME, suspicious of malignancy; background siliconomas
Final BI-RADS Classification	BI-RADS 4a	BI-RADS 5
MRI-guided biopsy	Not available	Not available
2nd look USG	Unable to visualize suspicious RUOQ lesion. USG-guided biopsy abandoned. Patient declined MRI-guided biopsy at another center. Requested MRI follow-up.	Few dilated right retroareolar ducts. with surrounding ill-defined low echogenicity. No increased vascularity nor definite intraductal lesion. HPE: Granulomatous mastitis

Surgical management	Bilateral mastectomy and axillary lymph node dissection	Right mastectomy and axillary lymph node dissection.
Intra-operative findings	Silicone material in subcutaneous tissues, breasts, pectoralis muscles and axillae bilaterally. Large axillary lymph nodes bilaterally.	Silicone material in all right breast quadrants, densely adhered to dermis. Dense fibrosis at axillary tail and pectoralis major muscles. Large right axillary lymph nodes.
Histopathology examination findings	Extensive fibrogranulomatous inflammation in both breasts with dense fibrosis, foreign body reactions and fat necrosis (silicone granulomas) Left breast had usual ductal hyperplasia with a focus of atypical ductal hyperplasia No evidence of malignancy in the axillary lymph nodes	Extensive fibrogranulomatous inflammation in the right breast with dense fibrosis, foreign body reactions and fat necrosis (silicone granulomas) Usual focal ductal hyperplasia, intraductal papilloma and fibrocystic disease. Few expanded ducts with features of moderate to high grade ductal carcinoma in-situ (DCIS), 0.5 and 2.0 cm from the superficial margin. No evidence of malignancy in the axillary lymph nodes
Histopathologic diagnosis	Extensive foreign body reaction with fat necrosis and silicone granulomas. Surgical margins were clear of atypical ductal hyperplasia.	Right focal high-grade DCIS with background of extensive silicone granulomas and silicone lymphadenitis
Outcome and Follow Up	No surgical complications. Discharged from breast clinic. Follow-up at primary health care clinic	No surgical complications. Planned for contralateral nipple and skin sparing mastectomy with immediate autologous breast reconstruction. Still under breast clinic.
Timeline Summary (Relative to initial presentation, T=0)	■ T= 0: Initial presentation to breast surgical clinic [> 10 years after FLSI and 1 year after symptom onset] ■ T < 1 month: MMG & USG ■ T = 5 months: 1st MRI ■ T= 1 year 2 months: 2nd MRI (6-month follow-up was deferred due to machine maintenance) ■ T= 1 year 5 months: Bilateral mastectomy. ■ T = 1 year 6 months - 2 years: Post operative follow-up. ■ T= 2 years: Discharged to primary health care clinic given that she was negative for malignancy.	■ T=0: Initial presentation to breast surgical clinic [> 30 years after FLSI, ~ 1 month after symptom onset] ■ T < 1 month: MMG & USG ■ T = 2 months: 1st MRI ■ T= 2.5 months: 2nd look USG + US-guided biopsy ■ T= 4 months: Right mastectomy. ■ T = 1 year & 2 months: Scheduled for prophylactic left mastectomy ■ Standard follow-up schedule (Local institutional practice): 2 weeks → 1 month → 6 months → annually for 5 years before discharge to primary care.

Abbreviations: RUOQ - Right upper outer quadrant; RLOQ - Right lower outer quadrant; RLIQ - Right lower inner quadrant; MMG- Mammogram; USG- Ultrasound; DCE-MRI- Dynamic Contrast-enhanced Magnetic Resonance Imaging; NME- Non-mass enhancement, TIC - Time intensity curves; T=0 - Time from initial presentation

Mammograms (MMGs) of both patients demonstrated increased breast densities with multiple round lesions, some containing calcifications, potentially obscuring significant masses or suspicious microcalcifications. One suspicious finding in patient 2's MMG was a right retroareolar asymmetric density. Complementary ultrasonography (USG) of both patients was limited to the evaluation of superficial anechoic cystic globules consistent with silicone cysts, interspersed with significant posterior shadowing and characteristic “snow-storm” appearance, impeding the visualization of deeper structures.

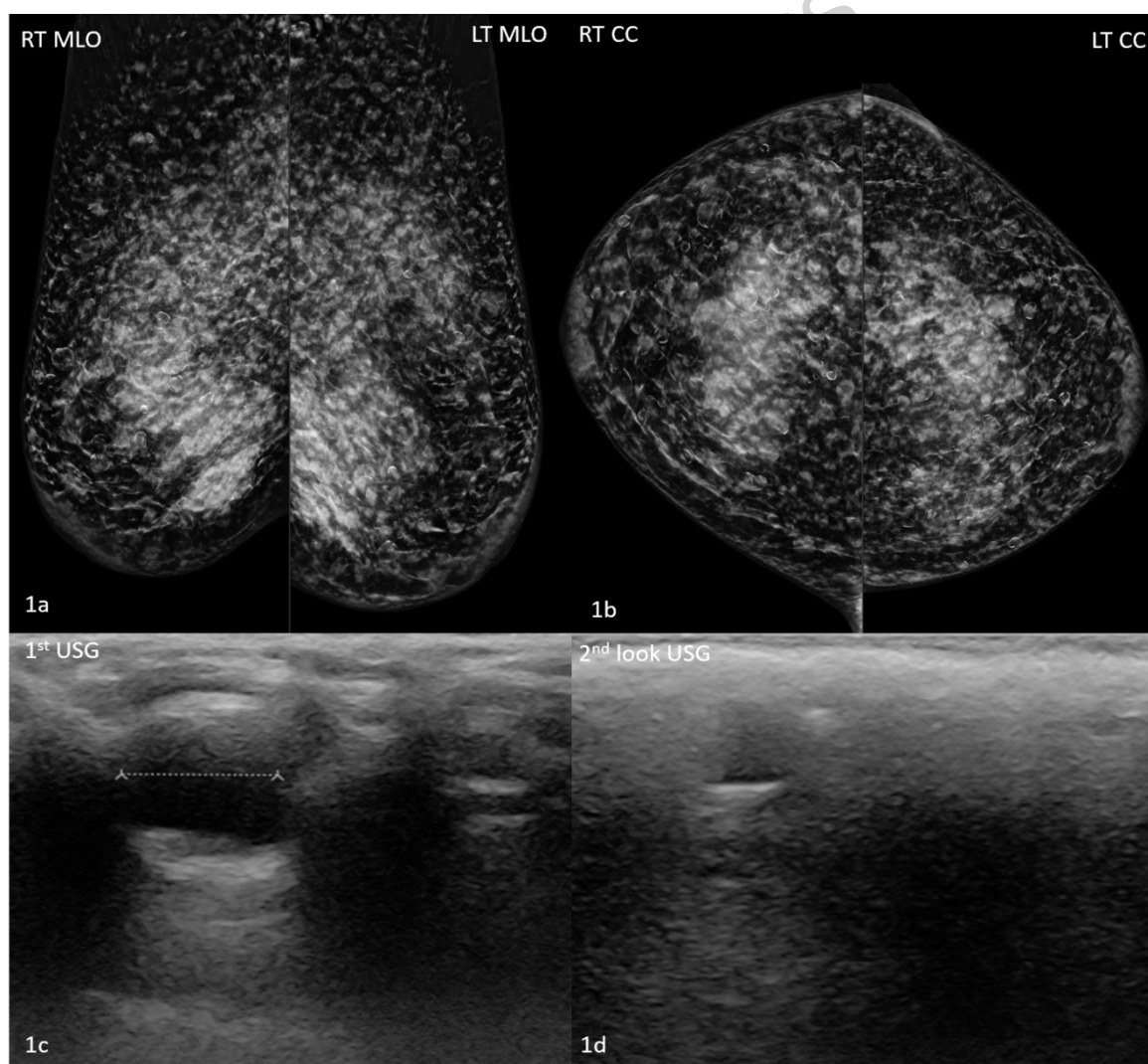


Figure 1: Patient 1's mammography (MMG) in (a) Mediolateral oblique (MLO) and (b) Craniocaudal (CC) views demonstrated innumerable, randomly distributed, round lesions of equal to high-density, some with peripheral rim calcifications representing silicone granulomas. Symmetrically increased retroglandular breast density was attributed to lipogranulomatosis and fibrosis. Adequate breast compression was limited by macromastia and marked tissue induration, resulting in incomplete imaging of the axillae and increased radiation exposure to achieve optimal tissue penetration. (c, d) pre-and post-MRI USGs images showed multiple superficial cystic globules (silicone cysts) within the breasts and axillae, with surrounding marked posterior shadowing.

Patient 1's MRIs demonstrated large, stable, bilateral mass-like sub-glandular fibrotic masses and multiple high T2WI signal globules. While several foci resolved, new lesions with similar characteristics appeared on the second MRI. One lesion in the right lower outer quadrant (RLOQ) (**Figure 2**) remained indeterminate due to persistent Type III enhancement characteristics. However, as its morphology and size remained stable, the leading differential diagnosis was granulomatous mastitis with low but non-negligible risk of malignancy (BI-RADS 4a).

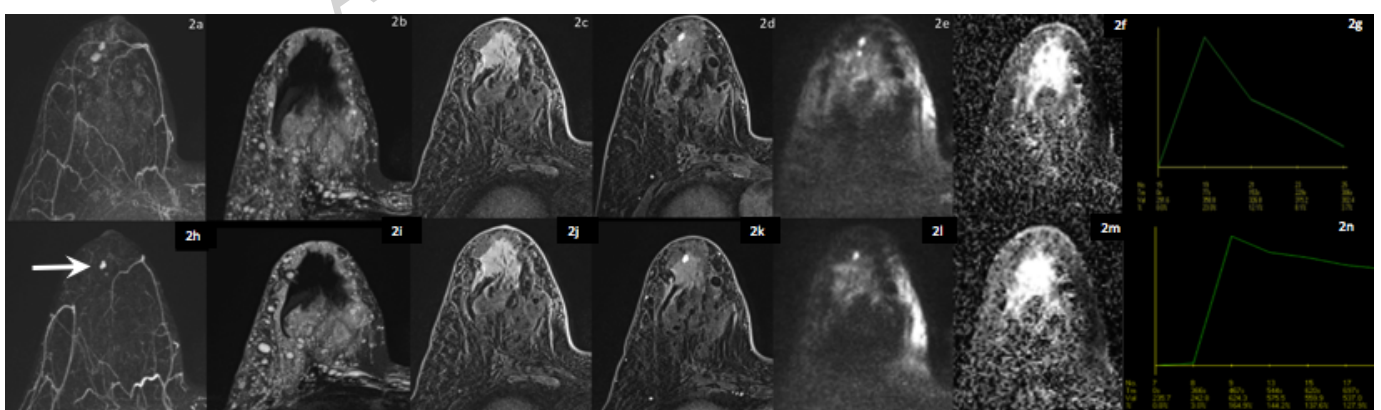


Figure 2: Patient 1's selected right breast MRI images obtained seven months apart, comparing the 1st MRI (a-g) and 2nd MRI (h-n). Sequences shown: (a, h) Maximum-intensity-projection computed aided detection (CAD-MIP) images, (b, i) Silicone-specific sequences, (c, j) Pre-contrast T1WI fat-saturated

sequence (T1FS), (d, k) Post-contrast T1FS sequences (T1FSCE), (e, l) Diffusion-weighted imaging (DWI), (f, m) and apparent diffusion coefficient (ADC) sequences. A persistent RLOQ circumscribed, oval lesion (white arrow), demonstrated persistent Type III time-intensity curve (TIC) but no interval changes in size and morphology. This lesion did not show high signal on silicone sequence (as expected of a siliconomas), enhanced homogenously post-contrast and showed persistent restricted diffusion. A second lesion located posterior to this lesion demonstrated similar imaging features but was not visualized in the 2nd MRI.

MRI-compatible biopsy equipment was not available in institution. Patient 1 declined referral to another center. Management options, including surgical intervention i.e., mastectomy versus serial imaging surveillance were discussed. Following her second MRI, she opted for bilateral subcutaneous mastectomy and axillary lymph node dissection. Intra-operative findings revealed extensive silicone material within bilateral subcutaneous, breast parenchyma and axillary soft tissues as well as the pectoralis muscles. Large axillary lymph nodes were also seen.

Gross pathological examination demonstrated solid greyish mass-like lesions with infiltrative borders and surrounding fibrosis in both breasts, larger on the right (RUOQ to RLOQ, 7.0 x 4.5 x 8.5 cm) than on the left (LUOQ, 3.5 x 4.0 x 3.0 cm) with clear resection margins. These correlated with the mass-like sub-glandular fibrotic changes observed on MRI. Multiple cystic locules of varying sizes (0.2-2.5 cm) were present throughout both breasts, the right pectoral floor and the left axillary tissues. A total of 17 right and 9 left axillary lymph nodes (0.4-1.2 cm) were retrieved. The overlying skin and nipples were unremarkable.

Microscopic analysis revealed extensive fibrogranulomatous inflammation characterized by dense fibrosis, numerous foreign-body type multinucleated giant cells, foamy histiocytes, abundant fine,

amorphous, acellular material with empty spaces, fibrocystic change and fat necrosis. On right breast sections, foci of microcalcifications, patchy lymphocytes and neutrophil infiltration were present. Similar foreign body reactions and fat necrosis were identified within the right pectoralis muscle. Left breast sections revealed usual ductal hyperplasia and a focus of atypical ductal hyperplasia (aggregate diameter of 0.1 cm) that showed intraductal proliferation of neoplastic cells comprising mildly pleomorphic, vesicular nuclei, occasional microcalcifications and rare foci of refractile foreign body material. Resection margins were clear of atypical ductal hyperplasia. There was no evidence of malignancy in the axillary lymph nodes, which demonstrated reactive lymphoid follicles with germinal centers and sinus histiocytosis. Patient 1's final diagnosis was silicone granulomas with extensive foreign body reaction and fat necrosis. The patient recovered well from surgery with no complications and is currently under primary health care clinic follow-up.

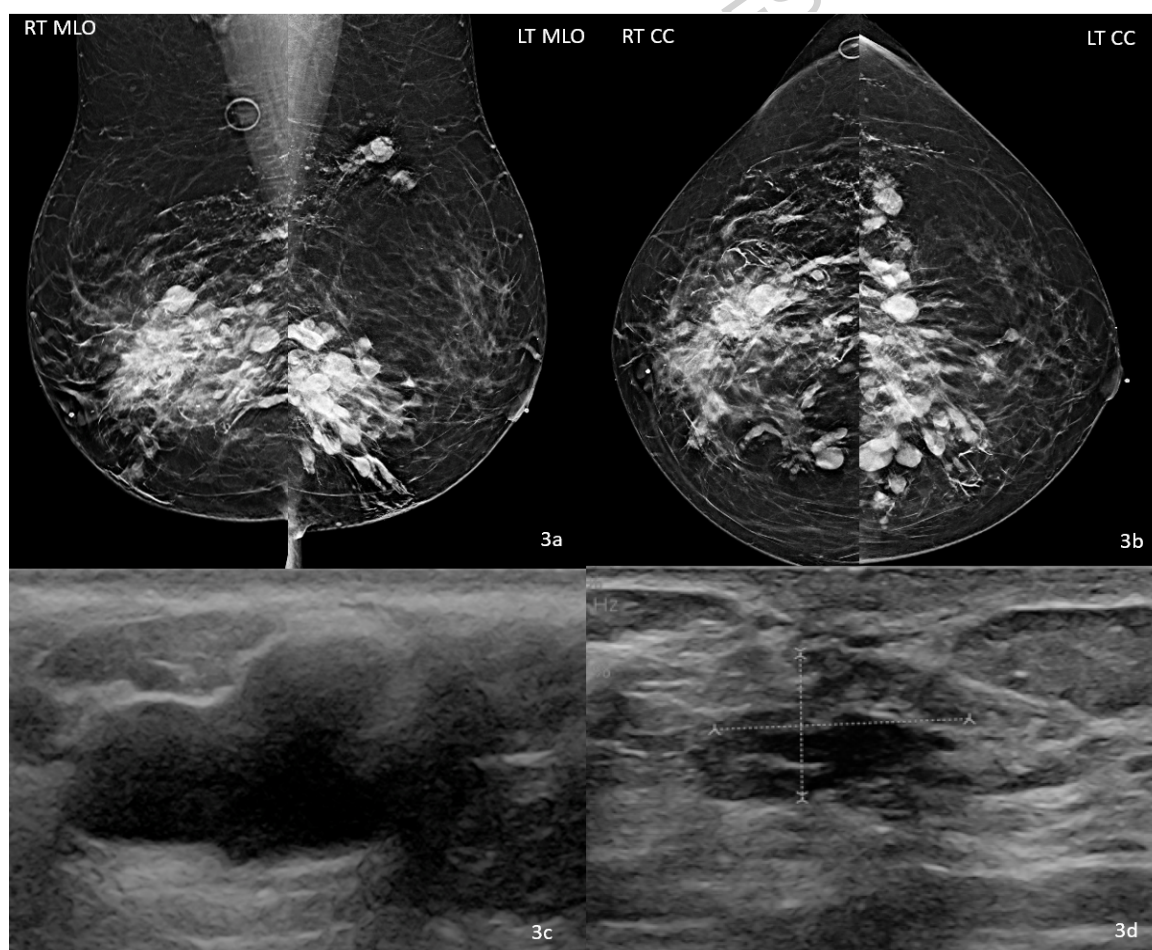


Figure 3: Patient's 2 mammography (MMG) in (a) MLO and (b) CC views demonstrated an asymmetric density in the right retroareolar region. Multiple macro- and micronodular round high-density lesions of varying sizes were seen in both breasts and the left axillary tail, representing siliconomas and silicone-related lymphadenitis. (c) Complementary USG revealed multiple superficial cystic globular lesions within the breasts and axillae, associated with marked posterior shadowing, similar to patient 1. (d) Second-look USG at the right retroareolar region demonstrated mildly prominent retroareolar ducts with surrounding ill-defined low echogenicity but no definite intraductal soft tissue lesion.

Patient 2's CE-MRI demonstrated numerous globules with high T2WI & silicone-specific signal intensities, varying in sizes in fibroglandular tissues, subcutaneous tissues, pectoralis muscles and axillae bilaterally. A large area of "clustered ring" non-mass enhancement (NME) in segmental distribution was identified, involving the right nipple areolar complex, RLOQ and right lower inner quadrant (RLIQ). This corresponded with the asymmetric density on MMG (**Fig 4**). Architectural distortion was also observed at the lower half of the left breast with no suspicious enhancement patterns or mass-like features, suggestive of fibrotic changes. Based on the suspicious morphology and distribution of the right NME, a BI-RADS 5 assessment was assigned.

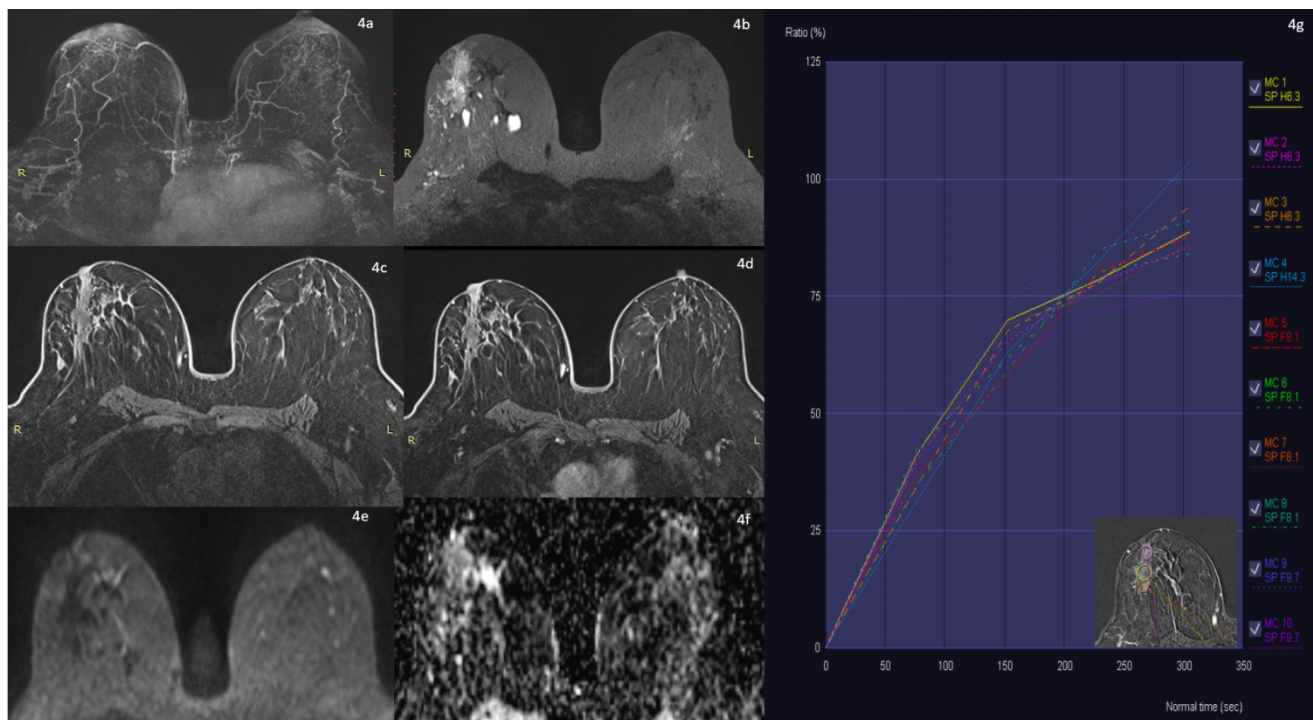


Figure 4: Patient 2's selected MRI images at the level of suspicion demonstrated: (a) MIP-CAD: Right lower outer and inner quadrant segmental, clustered-ring non-mass enhancement (NME) extending to the nipple-areolar complex. (b) Silicone-specific sequences: Scattered high-signal silicone globules. A few within the NME region demonstrated reduced high-signal intensity; (c) Pre-contrast and (d) post-contrast T1WI subtracted images showed asymmetrical right breast NME (e, f) DWI and ADC maps showed minimal restricted diffusion near the nipple and in the right inner lower quadrant, with no convincing restriction across most of the NME region; (g) Time intensity curve (TIC) predominantly demonstrated Type I-II enhancement patterns within the NME.

An USG-guided core biopsy was performed, targeting the ill-defined hypoechoic tissues surrounding dilated retroareolar ducts on second-look USG. Histopathologic examination revealed strips of fibrofatty breast tissue with chronic inflammatory cell infiltration, foreign-body type giant cell reaction, fibrosis, fat necrosis, and refractile, non-polarizable material within cytoplasmic vacuoles, consistent with silicone granulomas, discordant with the suspicious MRI features.

The patient subsequently underwent right nipple and skin-sparing mastectomy, sentinel lymph node biopsy and immediate breast reconstruction using an ipsilateral pedicled latissimus dorsi flap. Intraoperatively, multiple silicone granulomas were identified across all breast quadrants, densely adhered to overlying dermis at the RLOQ (7-8 o'clock) and RUOQ (10-11 o'clock). Dense fibrosis was also present in the axillary tail and pectoralis major muscles. Two-sentinel lymph nodes several enlarged nodes were excised. Frozen-section analysis of the nipple base demonstrated no evidence of malignancy.

Gross pathological examination showed a firm to hard mass-like lesion (6.0 x 5.0 x 1.5 cm) and multiple right axillary lymph nodes. Microscopic analysis demonstrated extensive fibrogranulomatous inflammation characterized by dense fibrosis, numerous foreign-body type multinucleated giant cells, abundant fine, amorphous, acellular material with empty spaces and fat necrosis. Focal intraductal papilloma, fibrocystic changes and usual ductal hyperplasia were also present. Several dilated ducts exhibited features of ductal carcinoma in-situ (DCIS), including cribriform architecture and comedo-type necrosis with moderate-to-high grade features, located approximately 0.5 cm from the superficial margin. No invasive carcinoma was identified. Five axillary nodes exhibited amorphous, acellular material within empty spaces, with no evidence of malignancy. The final diagnosis was focal high-grade DCIS of the right breast in the background of extensive silicone granulomatosis and silicone lymphadenitis. The patient-recovered uneventfully from her first operation and was scheduled for contralateral nipple- and skin-sparing mastectomy with immediate autologous breast reconstruction.

Discussion and Conclusion:

Combined MMG and USG were equivocal in Patient 1 due to superimposed fibrotic masses and extensive siliconomas, consistent with previously reported limitations of these modalities in FLSI

cases [3, 8-10]. In contrast, the asymmetric retroareolar density identified on Patient 2's MMG prompted earlier MRI evaluation than initially planned.

On DCE-MRI, overlapping enhancement characteristics between malignancy and inflammatory processes presented inherent diagnostic challenges [2, 3]. Earlier assumptions suggested that silicone granulomas and fibrosis are typically non-enhancing unless associated with malignancies or active inflammation [9,11]. However, Sonnenblick et al. (2021) reported variability in lesion size and enhancement characteristics in 21 transgender patients with FLSI; none had occult malignancies. [12]. Such variability was evident in both our cases. In Patient 1, the enhancing RUOQ lesion demonstrated suspicious type III TIC enhancement pattern but remained morphologically stable on follow-up MRI, favoring a benign inflammatory process.

In patient 2, the suspicious clustered-ring NME involved a significantly larger area than the focal DCIS confirmed by histopathology. Nevertheless, this descriptor is associated with DCIS and has been postulated to be caused by intraductal carcinoma with abundant blood supply [13]. Contrast media that accumulated in the periductal stroma and surrounding fibrogranulomatous inflammation likely contributed to the persistent TIC kinetic pattern in the NME area [13]. Imaging differentials for clustered-ring enhancements include complex sclerosing lesions, papillomas and fibrocystic disease [13].

Smaller enhancing foci (≤ 5 mm) were particularly challenging to characterize. Even though most foci demonstrated Type I-II enhancement patterns, several foci in patient 1 showed inconsistent kinetic patterns. Such variability might have resulted from partial-volume effects, technical factors and different acquisition parameters [7]. Therefore, enhancement kinetics alone should not be relied upon to differentiate benign from malignant lesions. Some authors have suggested that isolated foci, which

are more commonly benign (e.g., fibrocystic change, papillomas, intramammary lymph nodes), may be managed with short-interval imaging surveillance rather than immediate biopsy [3].

Table 2 summarizes published imaging features of siliconomas and FLSI-related breast complications. The appearances vary depending on silicone impurities, viscosity, extent of fat necrosis, fibrosis and the presence of concomitant disease [14-17]. This variability has also been reported in FLSI cases at other locations [15-17]. In a review by Ginat et al. 2013, higher viscosity silicone oils injected into the face tended to be iso- or hypointense to water on T2WI, in contrast to the high T2WI signal intensities typically reported in breast FLSIs [15]. Another case of disseminated silicone granulomatosis in a patient with ruptured breast implants and history of cosmetic facial fillers showed diffuse facial and orbital nodular soft tissue thickening and fat stranding [16].

Fat necrosis, found in both patients, is a benign inflammatory process of adipose tissues associated with FLSI, likely triggered by foreign body granulomatous inflammation. Fragmentation of adipose cells leads to formation of necrotic lipid material, multinucleated giant cells, foamy histiocytes [14]. The release of enzyme lipase into interstitium accounts for loss of cellular architecture and formation of amorphous clear cystic spaces, stimulating fibrinogen secretion and subsequent development of fibrosis and necrotic fat cavities [14]. Influx of neutrophils and lymphocytes in patient 1 indicated increased inflammation, corresponding to the rim-enhancing locules seen on MRI [11, 20].

The ACR-BIRADS lexicon remained the main reference for assessing the likelihood of malignancy versus benignity for foci, masses and non-mass enhancements observed in our cases [7,13]. Use of silicone-specific views, in addition to high T2WI FS/TIRM and low T1WI signal intensities increased certainty that most of the cystic locules consisted of silicone content with less likelihood of malignancy.

Lesion stability, absence of restricted diffusion on DWI/ADC, Type I-II enhancement kinetics and identification of silicone signal on silicone-specific sequences favor benignity. Features such as Patient 2's clustered-ring NME, the restricted diffusion in inflamed granulomas raised the suspicion of malignancy. However, given overlaps in likely benign and malignant features as seen in our cases, differentiation remains challenging, even on DCE-MRI. Ultimately, definitive diagnosis still requires histopathologic correlation.

Management strategies for FLSI-related breast complications remain non-standardized [8], although several authors have proposed diagnostic and treatment algorithms [2, 4, 18]. Short-interval MRI surveillance is generally recommended for low-risk patients while medical management options for silicone mastitis include intravenous antibiotics, corticosteroids and non-steroidal anti-inflammatory drugs (NSAIDs) [2, 4]. For high-risk patients with proven malignancy or silicone mastopathies, surgical options include subcutaneous mastectomy with implant-based reconstruction when the skin is uninvolved, or simple mastectomy with skin resection and autologous reconstruction when cutaneous involvement is present [2, 21].

Table 2: Literature Review - Imaging Features and Histopathologic Correlation of FLSI-Related Breast Complications

FLSI-Related Complications	MMG	USG	MRI	Histopathology Findings
Siliconomas (Silicone granulomas) [4, 5, 7]	<u>Number:</u> Innumerable [19]	<u>Snowstorm appearance:</u> Innumerable round anechoic cystic or ↓ echogenicity (hypoechoic) lesions/ globules with surrounding diffuse ↑ echogenicity due to interface between silicone, breast tissue and granulomatous reactions [1]	Innumerable, round globules with variable reported signal intensities.	<u>Granuloma:</u> An organized group of macrophages with an outer layer of lymphocytes, fibroblasts and vessels. A result of inflammatory tissue responses caused by foreign bodies, chronic infections or impurity [5, 11, 19, 20]
	<u>Size:</u> Variable [8, 19]		<u>MRI Sequences:</u> Silicone-specific sequence: ↑ signal intensity [12, 17]	
	<u>Shape:</u> Typically spherical		T2WI: ↑ [12, 17] or ↓ signal intensity [12]. Depends on impurities during preparation.	
	Micronodular, macronodular or mixed [5, 8]	Strong posterior shadowing due to strong reflection, refraction, reverberation, attenuation of USG beams by silicone fibrosis [1, 3, 8, 9, 11, 19, 20]	T2WI ↓ signal indicates fibrous component [5] or higher viscosity [15]. T2WI FS: ↑ /↔ signal intensity vs muscle [11]	<u>Silicone Granuloma:</u> Contains silicone vacuoles/ pseudocystic empty spaces and histiocytes with amorphous acellular material (dissolved silicone), surrounded by abundant fibrous/ foreign-body granulomatous inflammation & giant cell reaction, lacks true capsule, unlike a true cyst [5, 9, 12, 19]
	Foci ≤ 5mm Difficult to characterize [3, 7]		T1WI: ↓ [12, 17] or ↔ signal intensity [11]	
	Mass > 5 mm [3, 7]		DCE-MRI – T1CE/ T1CE FS: ↑/↓/↔ relative to BPE. Typically, non-enhancing, unless inflamed [1, 12]. TIC: Possibility of spurious results due to volume averaging artefact between siliconomas surrounding normal tissue at ROI [3]	
	<u>Density:</u> ↑ Radiodensity. Obscures underlying glandular tissue [1, 8, 10, 11]			
	<u>Margins:</u> Smooth but can have spiculated margins [5]			
	<u>Calcifications:</u> Peripheral [5, 8] Can mimic clustered microcalcifications but is “non-anatomical” on magnification views [1, 2]			
	<u>Distribution:</u> Randomly distributed [3, 11]			

Fibrotic Masses (FM)	Dense fibroglandular tissue [3, 10]	Strong posterior shadowing due to USG artifacts caused by silicone fibrosis. Obscures posterior parenchymal details – USG is of little value [1, 3, 8, 9, 11, 19]	<u>Fibrosis</u> [11]: T1WI ↓ & T2WI ↓ signal intensities DCE-MRI: T1CE in FMs > 4 cm [12]: - Enhance: 38.5% cases - Non-enhancing: 61.5% cases	Exuberant fibrotic hyperemic tissue enveloping innumerable/multiple, large and small vacuoles as well as normal ducts and lobules. Giant cell and foreign body reaction leads to progressive fibrosis, stromal remodeling, architectural distortion [12]
	Non-parenchymal fibrotic reaction that increases breast density			
	Discrete mass ≥ 2 cm with silicone vacuoles within [12]	Superficial and/or larger masses may be visualized [9]	<u>Masses - Suspicious features</u> [3,7,9,13]: - Irregular shape - Lobular mass without septations - Enhancing septations - Heterogenous mass enhancement - DCE-MRI: TIC - Rapid enhancement and washout kinetic - Overlaps exist between morphology and TIC patterns of malignant & benign lesions e.g., persistent/plateau curves can also be associated with malignancy	
	Dominant FM if > 4 cm [12]			
Silicone-related benign inflammatory processes and/or infection [4-5]	<u>Fat necrosis:</u> [14, 20] Coarse, central dystrophic, calcifications	<u>Fat necrosis:</u> [14, 20] Variable appearances: Solid echogenic mass. Can mimic suspicious lesions e.g. taller than wide, angular margins.	<u>Fat necrosis:</u> [14, 20] Variable appearances. Depends on the extent of necrosis and stage of evolution. - Necrotic central fat: T1WI ↑ signal - T1WI FS ↔/↓ signal vs remaining fat in breasts +/- architectural distortion STIR: ↓↓↓ signal; “Black hole sign” - DWI/ADC: Typically, no restricted diffusion (vs malignancy) - Fibrotic rim (thin, thick, irregular/spiculated): T1CE ↑↑ signal at early stage, decreases with time - Oil cysts: ↑ T1WI signal intensity - Kinetic analysis is less helpful	<u>Fat necrosis:</u> [14, 20] Co-exists with siliconomas. Intracellular vacuoles with necrotic lipid material.
	Oil cysts: Encapsulated lucent mass, rim calcifications; can collapse			Surrounded by lipid-laden macrophages/foamy histiocytes, multinucleated giant cells, acute inflammatory cells, fibrosis, and cellular debris.
	Focal asymmetry Spiculated or indistinct margins	Complex intracystic mass +/- small cysts +/- fluid-debris level		The greater the necrotic component, the greater the inflammation.

Silicone-related benign inflammatory processes and/or infection [4-5]	<u>Infections:</u> [17] Parasitic masses can present with serpinginous calcifications +/-mass	<u>Abscess:</u> [17] Irregular, ill-defined complex hypoechoic or cystic mass +/- peripheral Doppler signal	<u>Silicone Mastitis:</u> [1, 11, 17] Recurrent/ chronic inflammatory response can lead to tissue injury, progressive fibrosis [1] Variable enhancing features: [11] - May not enhance - Rim-enhancing - Symmetrical fibroglandular enhancement - Patterns: Diffuse, with rim-enhancing granulomas or regional NME with diffuse foci [1]	<u>Silicone mastitis:</u> [11] Extensive fibrogranulomatous inflammation Variable silicone vacuoles surrounded reactive fibrosis (corresponding to rim enhancement) and foreign-body type multinucleated giant cells, inflammatory cells, foamy histiocytes
	Mammary tuberculosis can mimic masses/ malignancy +/- calcified axillary nodes <u>Silicone lymphadenitis:</u> High densities at axillae. Result of silicone migration. Can be indistinguishable from breast cancer.	Fistulas or sinus tracts Lymphadenopathy/ lymphadenitis	Suspicious NME features in ACR-BIRADS e.g. clumped, clustered-ring, segmental, regional, linear (ductal) lexicon [7] <u>Infection:</u> [17] - Focal or diffuse - Typically asymmetric NME - Sinus tract/ fistula - Lymphadenopathy/ lymphadenitis	<u>Indicators of infection:</u> [17] Granulomas may show central/ caseating necrosis (cheese-like appearance) in tuberculosis, syphilis, some fungi, histoplasmosis, cryptococcus Granulomatous inflammation can also be due to autoimmune disease, sarcoidosis or idiopathic

Abbreviations: ↑ High signal; ↔ Intermediate signal; ↓ Low signal; BPE: Background parenchymal enhancement; DCE-MRI: Dynamic contrast enhanced MRI; T1WI: T₁-weighted image; T2WI: T₂-weighted image; FS: Fat saturated; T1CE: T₁-weighted contrast enhanced images; DWI: Diffusion-weighted imaging; ADC: Apparent Diffusion Coefficient; STIR: Short-Tau Inversion Recovery; Time-intensity Curves; ROI: Region of Interest; NME: Non-mass enhancements i.e., patterns of enhancement distinct from vascular or normal surrounding breast parenchyma enhancement with no mass effect.

In both cases, diagnostic certainty was hindered by the lack of MRI-guided biopsy equipment as well as a discordant USG-guided core biopsy result for patient 2. Although Cheung et al. (2002) reported successful malignancy detection with USG-guided core needle biopsy, similar results could not be obtained in our cases [9]. Potential contributing factors include differences in operator experience, USG equipment quality and lesion sizes - larger in their study (1.6 cm and 3.0 cm respectively) [9]. Patient-specific considerations further influenced management decisions, including patient 1's discomfort with prolonged MRI positioning and patient 2's heightened anxiety over a potential malignancy. Following multidisciplinary counseling, both patients elected surgical management and recovered without complications.

This study is limited by its retrospective design and small sample size of only two cases, predisposing the findings to selection and information bias. Comprehensive case capture was not possible due to the rarity of FLSI presentations at our institution and the absence of regional registries documenting such cases. Ideally, comparative longitudinal studies with larger cohort and control groups will better define optimal diagnostic pathways and quantify malignancy risks in this population. Data limitations include the retrospective extraction of histopathologic findings without secondary slide review. The exact composition and purity of the substances injected also could not be determined. Additionally, surgery and histopathologically assessments were performed by different specialists – reflecting real-world practice. While surgical specimens provided extensive tissue for evaluation, they were less targeted than image-guided core biopsies, limiting individual lesion characterization.

In conclusion, siliconomas and their complications can mimic or mask malignancy. Overcoming these diagnostic hurdles requires awareness of their multimodal imaging appearances and understanding of underlying histopathology. Replacing standard MMGs and USGs entirely with MRI is a clinical governance challenge, requiring subspecialized expertise, technical upgrades, and MRI-guided biopsy

capabilities. Validated, evidence-based guidelines specific to FLSI are essential to standardize interpretation and to ensure safe patient care.

List of Abbreviations:

FLSI	Free Liquid Silicone Injections
ACR	American College of Radiology
BI-RADS	Breast Imaging Reporting and Data System
MMG	Mammography
USG	Ultrasonography
MRI	Magnetic Resonance Imaging
DCE-MRI	Dynamic contrast-enhanced Magnetic Resonance Imaging
NME	Non-mass enhancement
T1WI	T ₁ -Weighted Imaging
T1CE	Contrast-enhanced T1-WI
T2WI	T ₂ -Weighted Imaging
DWI	Diffuse Weighted Imaging
ADC	Apparent Diffusion Coefficient
TIRM	Turbo Inversion Recovery Magnitude
FS	Fat Saturated
MIP	Maximum-Intensity-Projection
CAD	Computed Aided Detection
TIC	Time Intensity Curve

Declarations:

Ethics approval: Only secondary data were retrospectively utilized with no clinical intervention. The manuscript has been sufficiently anonymized with no direct or indirect identifiers, and will not breach confidentiality or cause harm to the patients or their next of kin. Ethics approval therefore, was waived by the Malaysian Medical Research & Ethics Committee, Ministry of Health [Reference No: 24-01413-JTP].

Consent for publication: Written informed consent was obtained from the patients for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in Chief of this journal.

Data availability: Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study. The data that supports the findings of this study are not publicly available due to ethical restrictions and confidentiality, but available upon reasonable request from the authors and with permission from the Malaysian Ministry of Health Director General.

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GWYL is the principle and corresponding author in charge of conceptualization & design, data acquisition, analysis, writing of the original draft, review, editing and accountability. BJ aided in acquisition, analysis, revision, validation and accountability. CSD and SB contributed in analysis, interpretation, review, revision, supervision, validation and accountability.

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