Chapter 6
Breast MRI and Implants

Claudia Seuss and Samantha L. Heller

Abstract Breast augmentation is the most common cosmetic surgical procedure performed in the United States. Magnetic resonance imaging (MRI) is the most sensitive modality for evaluating implant integrity. MRI also has the potential to detect breast cancer in women with implants. This chapter reviews the use of breast MRI in women with implants for identification of implant rupture and breast cancer detection. Implant imaging pitfalls as well as future MRI techniques and sequences for evaluating breast implants will also be addressed.

Keywords Breast implants • MRI • Silicone • Saline • Intracapsular rupture • Extracapsular rupture • Implant integrity • Radial folds • Breast cancer • Diffusion Weighted Imaging (DWI) • Spatiotemporally encoded (SPEN) • Anaplastic lymphoma

6.1 History of Breast Implants

The history of breast reconstruction dates back to 1895, when Czerny used a lipoma from a patient to augment her breast after removal of an adenoma [1]. After this, in the early 1900s there are reports of paraffin injections used for breast augmentation; however, due to the high incidence of complications including tissue necrosis, inflammatory reactions, draining sinus tracts and hard masses termed 'paraffinomas' its use was discontinued by the 1920s [2]. In the late 1940s surgeons experimented with plastic implants including silicone sponges. Shortly after their development however, many complications including capsular contracture, seroma, fistulation and infection became apparent and their use rapidly declined. In the 1940s and 1950s silicone injections became popular. However it was soon noted that pure liquid silicone tended to migrate away from the injection site. This fueled the idea of adding fibrosing agents such as vegetable oils and fatty acids to silicone;

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however these were not well tolerated and produced painful silicone granulomas, skin sloughing, granulomatous hepatitis, embolism and even death. With such serious complications, these injected substances were banned in many countries.

In 1963, Dr. Thomas Cronin introduced what is now recognized as the modern silicone gel-filled implant, created by placing silicone gel in a bag consisting of rubberlike silicone elastomer [3]. The first generation of silicone gel-filled implants, which were manufactured between the 1960s and 1970s had a thick shell, a peripheral seam and a backing of Dacron mesh, which was meant to promote tissue ingrowth and fixation along the posterior surface. From mid 1970s to the late 1980s a second generation of silicone gel-filled implants were manufactured, which had a thin elastomeric shell, and less viscous silicone gel. The third generation of silicone gel-filled implants, which have been produced since the 1980s have a multilayer shell, with a barrier layer and thick silicone gel. Although saline filled implants never attained the popularity of the silicone-gel filled implant, they have been used since the 1960s in the United States [2].

Concerns about implant related complications led the FDA to place a moratorium on commercially available silicone breast implants in 1992, limiting their use to patients requiring breast reconstruction and replacement of existing implants. Potential feared complications included low birth weights of infants born to women with silicone implants and increased incidence of brain tumors and suicide rates in women with silicone implants. The most widely publicized concern was related to the development of collagen vascular disease in women with silicone implants due to an immunologic response [4]. Eleven years later, following 15 studies involving 34,000 subjects, with 7–15 years of follow-up data and no evidence of the above mentioned complications, the FDA allowed implants back on the market [4].

6.2 Types of Implants

There have been innumerable types, styles and sizes of implants developed over the past century. Different shapes, sizes, components, shell texturing, fixation patches and valves have been developed to provide sufficient variation for women. In their review of breast implant classification, Middleton and McNamara noted over 240 breast implant styles from American manufacturers alone [2].

The most frequently encountered breast implant is the single-lumen silicone gel filled implant, which consists of an outer silicone elastomer semipermeable implant shell filled with silicone gel (Fig. 6.1). The silicone gel is a lightly crosslinked polymer of polydimethylsiloxane (PDMS) [5]. Single-lumen implants also come in an adjustable variety, in which saline can be added to the lumen at the time of placement [2]. Saline implants consist of the same silicone elastomer shell, and are filled centrally with saline. These implants often have a fill valve which is visible on imaging.

Less commonly encountered is the standard double-lumen implant, which consists of a silicone gel filled inner lumen and a saline outer lumen. The primary

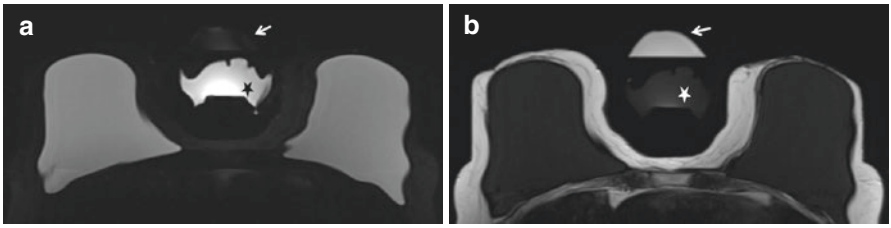

Fig. 6.1 (**a**) Axial STIR with water suppression (silicone sensitive) MRI image showing bilateral intact silicone implants. Signal from the saline component of the phantom (*white arrow*) is suppressed. High intensity signal from the silicone component of the phantom (*black star*) matches the high signal of the silicone implants. (**b**) Axial STIR with silicone suppression MRI image showing bilateral intact silicone implants. There is high intensity signal from the saline component of the phantom (*white arrow*). Suppressed signal from the silicone component of the phantom (*white star*) matches the suppressed signal of the silicone implants

purpose of this implant type is to allow size adjustability at the time of and after implant placement. A reverse double lumen implant, most commonly used after reconstructive surgery, consists of a saline filled inner lumen and silicone gel outer lumen. Size adjustments can be made by adding saline to the inner lumen while preserving the feel of a silicone gel-filled implant. A gel-gel double lumen implant consists of silicone gel within the inner and outer lumens.

Additional more rarely encountered implants on the market include reverse-adjustable, triple-lumen, double lumen Cavon "cast gel", custom, soft pectus, non-adjustable sponge, adjustable sponge and others [2].

Breast implants can be placed behind the glandular tissue but anterior to the pectoralis major muscle (termed subglandular, retroglandular or retromammary position). This position maximizes the augmentation effect of the implant, but obscures more breast tissue on mammogram, limiting evaluation. Alternatively, implants may be placed posterior to the pectoralis muscle (termed subpectoral or retropectoral position); this is the case for all implants placed after total mastectomy [6]. After placement, a thin fibrous capsule of scar tissue normally forms around the implant. On occasion, pronounced fibrous capsule formation can occur with silicone implants, which causes discomfort and alters the shape of the breast. This is known as capsular contracture and can be difficult to diagnose by imaging. Although surgically more challenging to place, advantages of subpectoral implants include lower rate of capsular contracture and easier imaging of the surrounding breast tissue [1].

6.3 Imaging of Implants

Breast augmentation is the most common cosmetic surgical procedure performed in the United States, and has been since the FDA re-approved the use of silicone implants in 2006. In 2014 there were 286,254 cases of breast augmentation with

implants reported, a 35 % increase since 2000 [7]. With the widespread prevalence and ever increasing number of women with implants, there is an ongoing need to evaluate breast implant integrity as well as to identify breast cancer in women with implants.

6.4 Mammography

The primary indication for performing mammography in women with implants is to detect breast cancer. Conventional mammography is of little value in the assessment of implant integrity, with sensitivity ranging from 25 to 68 % [8] (Fig. 6.2). The sensitivity of screening mammography for detecting malignancy is also decreased in the presence of implants and has been reported at 45 % versus 67 % in patients without implants [9]. Mammography does however remain useful for the evaluation of the surrounding breast tissue and for the detection of extracapsular silicone rupture. Additionally, mammography can identify periprosthetic calcifications, which are occasionally seen with capsular contracture as well as focal bulges or contour deformity of the implant shell. Given that mammography is the main screening tool to identify breast cancer in women, annual mammography is still recommended in patients with implants.

6.5 Ultrasound

There are conflicting reports on the usefulness of ultrasonography for detecting implant ruptures, which may reflect the variation in exam quality depending on the experience of the operator, type of equipment used, and technical factors [8]. Ultrasound can delineate some of the internal structure of the implant, particularly in the anterior aspect and therefore can detect both intracapsular and extracapsular rupture. Intracapsular rupture is seen as a series of horizontal echogenic straight or curvilinear lines traversing the interior of the implant, commonly known as the step-ladder sign [10] (Fig. 6.3). Extracapsular silicone has the characteristic "snowstorm" appearance characterized by a highly echogenic pattern of scattered and reverberating echoes with a well-defined anterior margin and loss of detail posteriorly (Fig. 6.4). Ultrasound is also able to detect small amounts of free silicone within axillary lymph nodes, manifesting as the characteristic echogenic snowstorm appearance.

Ultrasound has proven to be useful in patients who are claustrophobic or unable to undergo MRI because of unsafe implanted devices such as pacemakers. Importantly however, silicone does cause marked attenuation of the ultrasound beam; thus evaluation of the back wall of an implant and the tissue posterior to it is limited. Additionally, previous silicone injections and residual silicone granulomas from extracapsular rupture will significantly limit ultrasound evaluation [11].

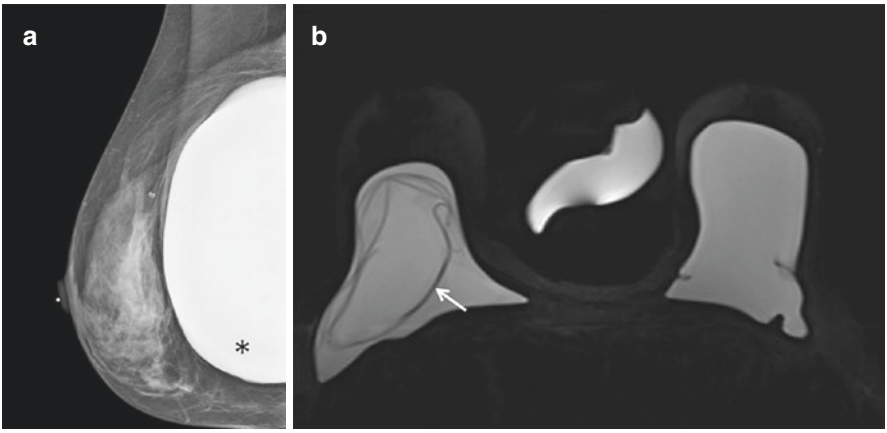

Fig. 6.2 (**a**) Right MLO view mammogram shows a subpectoral silicone implant, which appears intact (*black asterix*). (**b**) Axial STIR with water suppression (silicone sensitive) MRI image from the same patient demonstrates the "linguine sign" (*white arrow*) of intracapsular implant rupture on the right, which was not detected on mammography performed the same day

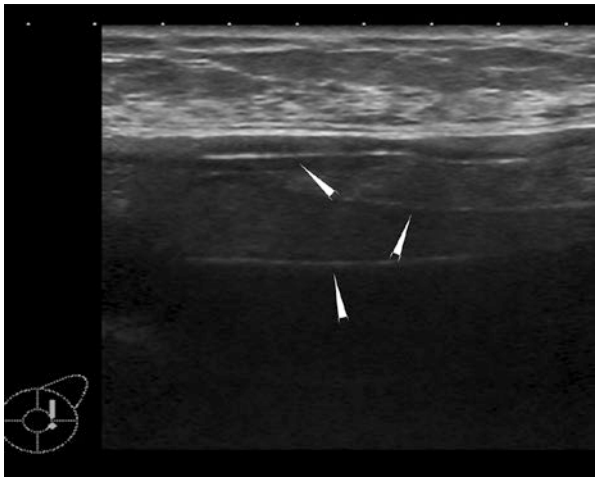

Fig. 6.3 Image from an ultrasound demonstrates the stepladder sign of intracapsular silicone implant rupture (*white arrowheads*). The discontinuous parallel echogenic lines represent the collapsed implant shell within the implant lumen

6.6 Magnetic Resonance Imaging

Magnetic resonance imaging is the most accurate noninvasive method available to evaluate silicone gel-filled implant integrity. The FDA currently recommends that asymptomatic women with silicone implants undergo an MR imaging examination to check for implant rupture 3 years after placement and then every 2 years thereafter. In addition, MR imaging is recommended to evaluate for implant rupture if the patient is having new breast symptoms [12]. This is because although clinical signs of implant rupture may include contour deformity, displacement, and mass formation,

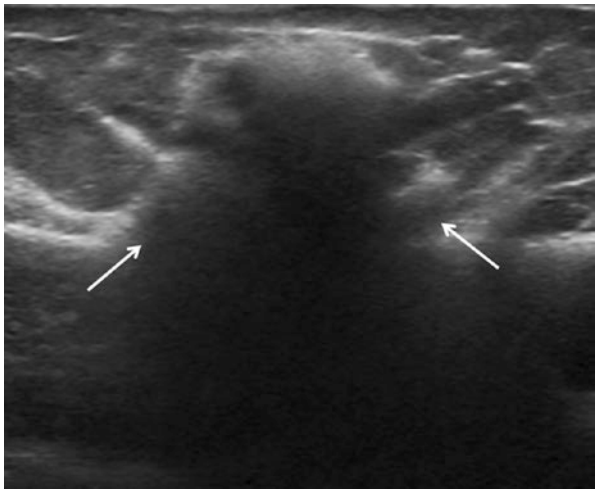

Fig. 6.4 Image from an ultrasound demonstrates the "snowstorm" pattern of extracapsular silicone implant rupture (*white arrows*)

the diagnosis of implant rupture based on physical exam findings is extremely insensitive, with failure to diagnose implant rupture in greater than 50 % of ruptures [13]. The overall sensitivity of MRI for detection of implant rupture is between 80 and 90 % and its specificity is between 90 and 97 % [14].

6.6.1 MRI Sequences

Currently breast implant imaging can be performed on 1.5 and 3 T MR scanners from all major manufacturers using a dedicated breast imaging coil. Studies are performed in the prone position to minimize respiratory artifact and to allow the implant to be imaged in maximum size. The MR sequences that are used in silicone implant imaging are strategically developed to separate three main components: water, silicone and fat [4].

We find imaging of a saline bag/silicone phantom to be helpful both in terms of aiding confirmation of implant material, but also as a quality control measure for signal suppression (Fig. 6.1). Implant sequences can be performed using 5 mm slices and can be performed in under 15 minutes; however, a longer high resolution sequence may be useful for thin shell and some standard double-lumen implants when early rupture detection is difficult.

We suggest that MRI to evaluate for implant rupture should include a scout localizer sequence, to help plan other sequences. The scout sequence is useful for example, in the rare situation when extracapsular silicone has spread outside the normal field of view (FOV), and can be utilized to plan extended FOV studies. A bilateral 2D axial T2-weighted turbo spin-echo sequence is used to differentiate water from silicone in cases of failure of nulling or suppression.

A bilateral 2D axial short tau inversion recovery sequence with water saturation is the main sequence used to detect intracapsular and extracapsular rupture of silicone implants. In this sequence silicone will appear hyperintense against a dark background of fat and water suppressed images. The dark implant shell folds will contrast with the bright silicone gel in cases of intracapsular rupture.

A bilateral 2D axial short tau inversion recovery sequence with silicone saturation is used to increase confidence in detecting extracapsular soft-tissue silicone. In this sequence, water and fat will appear hyperintense, and silicone will be hypointense, and thus extracapsular silicone will appear dark against a bright background. This sequence is not used to detect intracapsular implant rupture because the hypointense implant shell folds are not well seen against the background of suppressed (hypointense) silicone gel.

Additional sequences used to evaluate implant integrity at our institution include a bilateral 2D axial STIR, bilateral 2D axial T2 and a bilateral 2D axial T1-weighted volumetric interpolated breath-hold examination (VIBE) (see Table 6.1).

6.7 Implant Integrity/Complications

The normal silicone implant should have a smooth, well-defined margin with homogeneous appearance of silicone on MRI. Breast silicone implants are designed to approximate the cosmetic ptosis of a normal breast and, thus are not meant to be taut.

Table 6.1 Protocol for implant evaluation (3 T magnet)

Description	Main parameters	Uses
Bilateral 2D axial T2-weighted unsupressed, breast coil	Turbo spin-echo, 5 mm slice thickness, TR 3000 ms, TE 79.0 ms, 384 × 288 matrix, 1 average	Allows differentiation of water from silicone in cases of nulling/suppression failure
Bilateral 2D axial STIR, breast coil	Turbo spin-echo, 5 mm slice thickness, TR 3500 ms, TE 61.0 ms, 320 × 256 matrix, 2 averages	Used in conjunction with unsuppressed T2 to confirm fat signal, which will be hypointense on this sequence
Bilateral 2D axial STIR, silicone saturated, breast coil	Turbo spin-echo, 5 mm slice thickness, TR 4000 ms, TE 61.0 ms, 320 × 256 matrix, 2 averages	Used to confirm the presence of extracapsular silicone, which will appear hypointense
Bilateral 2D axial STIR, water saturated, breast coil	Turbo spin-echo, 5 mm slice thickness, TR 4000 ms, TE 61.0 ms, 320 × 256 matrix, 2 averages	Main sequence to detect intracapsular and extracapsular implant rupture
Bilateral 2D axial T1- weighted VIBE, breast coil	Gradient echo, 0.9 mm slice thickness, TR 3.78 ms, TE 1.11 ms, 448 × 358 matrix, 1 average	High resolution sequence useful for thin shell and some standard double-lumen implants when early rupture detection is difficult. Can also be used to evaluate non-implant related breast findings

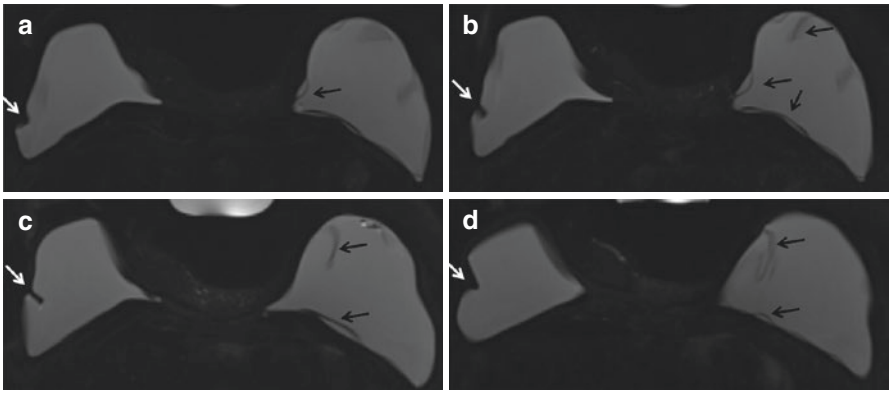

Fig. 6.5 Axial STIR with water suppression (silicone sensitive) MRI image demonstrates a radial fold (*white arrow*) on multiple slices of the right breast implant (**a**–**d**). When scrolling through the entire sequence, the radial fold extends to the surface of the implant shell. This is in contrast to the hypointense curvilinearities signaling intracapsular rupture ("linguine sign") seen in the left implant (*black arrows*) (**a**–**d**)

This means when an under-filled implant is placed into a confined space, it in-folds on itself as needed to conform to the space, and as such minor rippling or undulation is a normal finding on MR imaging. This commonly seen fold pattern can cause confusion as it mimics implant rupture; however normal folds should extend from the edge of the implant shell inward (Fig. 6.5). Additionally, no silicone should ever be seen outside the implant as a whole, along the inner surface of the fibrous capsule or within the folds themselves.

6.7.1 Intracapsular Rupture

When breast implants fail, the most common cause is a small defect or worn area of the implant shell. A large percentage of implant failures occur during surgical implantation; however tears can also occur in-vivo. While trauma can cause an implant to rupture, most implant ruptures have no identifiable cause. The most important factor predisposing an implant to rupture is age of the implant. Historically the prevalence of implant rupture is approximately 30 % at 5 years after implantation, 50 % at 10 years and 70 % at 17 years, with the median age of implants at rupture being around 10.8 years [15]. Additional studies, however, have shown lower rates of implant rupture with later-generation silicone implants [16–18].

When there is a defect in the implant elastomer shell, silicone gel will slowly ooze out, but will be contained in the intracapsular space by the outer fibrous capsule. Over time the escaped silicone contained by the fibrous capsule will surround the implant elastomer shell and cause it to collapse into the pool of remaining silicone.

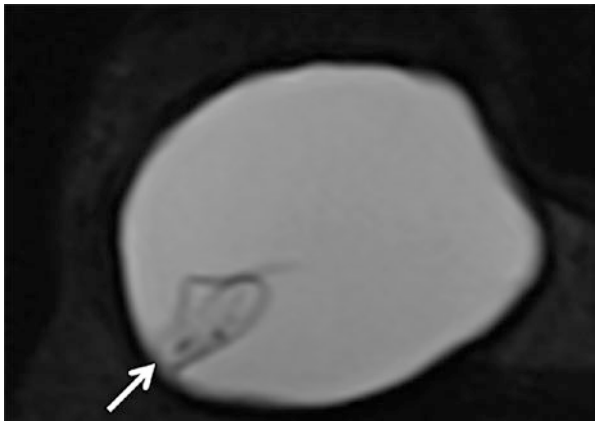

Fig. 6.6 Axial STIR with water suppression (silicone sensitive) MRI image shows the "keyhole" sign (*white arrow*) of intracapsular rupture on the right. At surgical explantation, right intracapsular implant rupture was confirmed

Four categories of implant intracapsular rupture have been described, from early to advanced; these include uncollapsed, minimally collapsed, partially collapsed and fully collapsed [19]. Describing intracapsular rupture by stage using these common terms can be helpful and informative for surgeons and patients when making clinical decisions.

Uncollapsed, or very early implant rupture is seen as silicone gel present in folds outside of the implant shell but contained by the fibrous capsule. This has been referred to by a variety of names including the inverted-loop sign, keyhole sign, teardrop sign or hangnoose sign. This occurs when silicone oil osmotically transgresses the intact elastomer shell and adheres to the fibrous capsule. Later when a tear occurs in the elastomer shell, the liquid silicone will slowly leak out; however it cannot circumferentially extend between the shell and the capsule, as it is confined by the shell-capsule adherence. As a result, the exiting silicone gel accumulates focally and begins to invaginate the otherwise intact regions of the elastomer shell; this has the appearance of a keyhole. This is the most common sign of implant rupture, but it is less specific than other signs described below, especially in cases with motion artifact or suboptimal slice thickness when the keyhole sign can be confused with normal radial folds (Fig. 6.6).

Minimally collapsed intracapsular implant rupture occurs when silicone gel is seen within shell in-foldings as well as between stretches of the implant shell and fibrous capsule. This appearance has been called the 'subcapsular line' or 'back-patch' sign and is seen as dark signal paralleling the dark signal of the fibrous capsule with silicone on both sides.

The 'C-sign' has been used to describe partially collapsed intracapsular implant rupture, and describes a finding seen only with implants from the late 1960s and early 1970s. These implants had thick shells which tended to curl when the implant shell collapsed to the point where there was not enough silicone gel remaining to keep the shell-patches flat. This sign is rarely seen today as these implants are now quite old.

The final and most advanced stage of implant rupture, known as fully collapsed, occurs when the implant shell is completely collapsed within the silicone gel that it

used to contain. The elastomer shell which is dark on MR imaging appears as wavy lines within the silicone gel. This curvilinear appearance has been called the "linguine" or 'wavy-line' sign and is the most specific sign of intracapsular implant rupture (Fig. 6.2b).

6.8 Saline Implants

As opposed to silicone implants, saline-filled implants do not rupture, but instead are said to deflate. If there is a defect in the shell or the valve of a saline-filled implant, the saline leaks into the breast parenchyma and will be resorbed within 5 days to 2 weeks. Imaging is not necessary as the clinical exam finding of a deflated implant will be obvious; however if imaging is done for another reason and there is a deflated saline-filled implant in place the appearance is characteristic (Fig. 6.7).

6.8.1 Extracapsular Rupture

If the fibrous capsule is disrupted for any reason, silicone that has escaped the elastomer shell can also escape through the capsule and into the breast, referred to as extracapsular rupture (Figs. 6.8 and 6.9). Extracapsular silicone can be seen as diffusely infiltrating silicone gel collections with or without their own fibrous capsules, silicone granulomas and silicone adenopathy [19].

Diffusely infiltrated silicone gel and silicone gel collections will have the same T2-weighted signal as the silicone contained within intact implants. Silicone granulomas and silicone adenopathy however, will appear less bright on T2-weighted

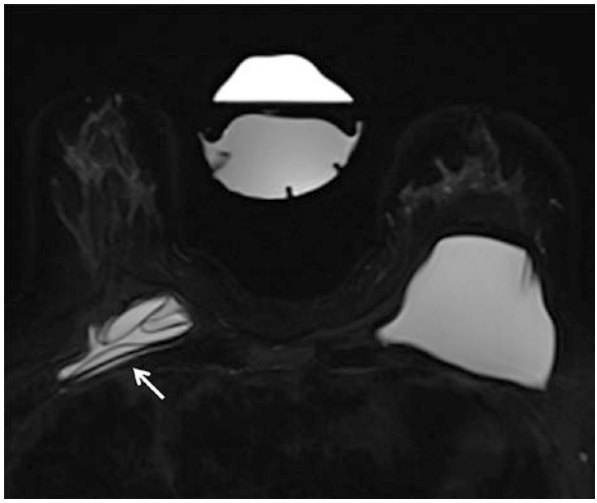

Fig. 6.7 Axial STIR image in a woman with bilateral saline implants demonstrates deflation of the right saline implant (*white arrow*). This patient also had clinical findings compatible with right saline implant rupture

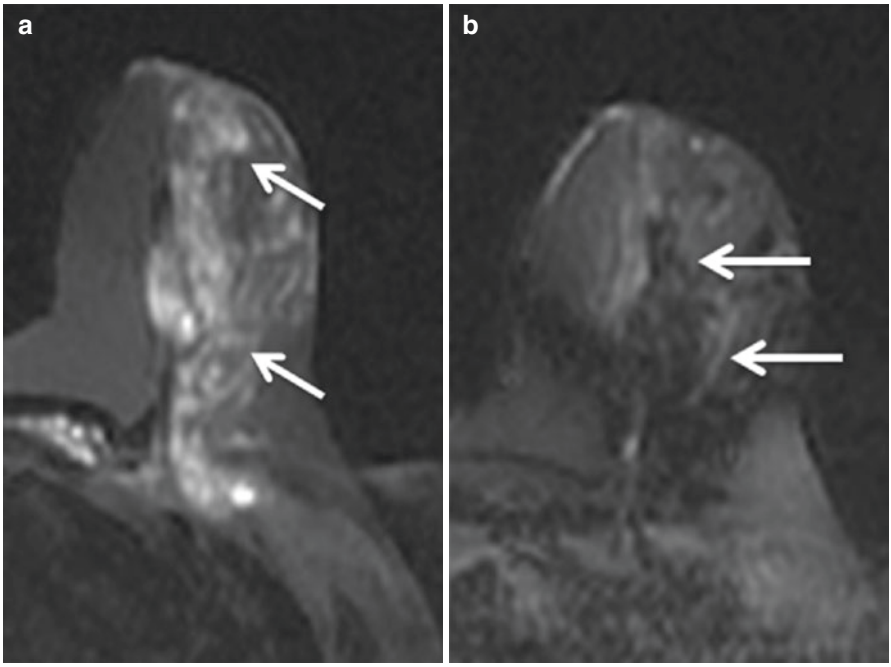

Fig. 6.8 (**a**) Axial STIR with water suppression (silicone sensitive sequence) MRI image demonstrates extensive hyperintense material throughout the left lateral breast (*white arrows*) compatible with extracapsular silicone. (**b**) Axial STIR with silicone suppression (water sensitive sequence) MRI image demonstrates the material in the left lateral breast is hypointense (*white arrows*), compatible with extracapsular silicone

sequences due to fibrosis and have a more heterogeneous appearance with scattered hyperintense T2 foci [19].

When silicone is seen outside the fibrous capsule without signs of intracapsular rupture this should raise the possibility that the current implants are replacements for previously removed implants. Silicone remnants are occasionally inadvertently left in the breast and other times en-bloc removal of the entire implant is not feasible.

6.9 Pitfalls

The most common interpretation pitfall in MR imaging of implants is distinguishing complex folds from the linguine sign of intracapsular implant rupture. The key to differentiating between these entities is to scroll through the images and evaluate whether or not the folds extend all the way to the fibrous capsule surface, a finding which strongly suggests normal folds. Additionally, evaluating the implants in at least two orthogonal planes can be helpful when there is a questionable finding which may be normal folds versus intracapsular rupture.

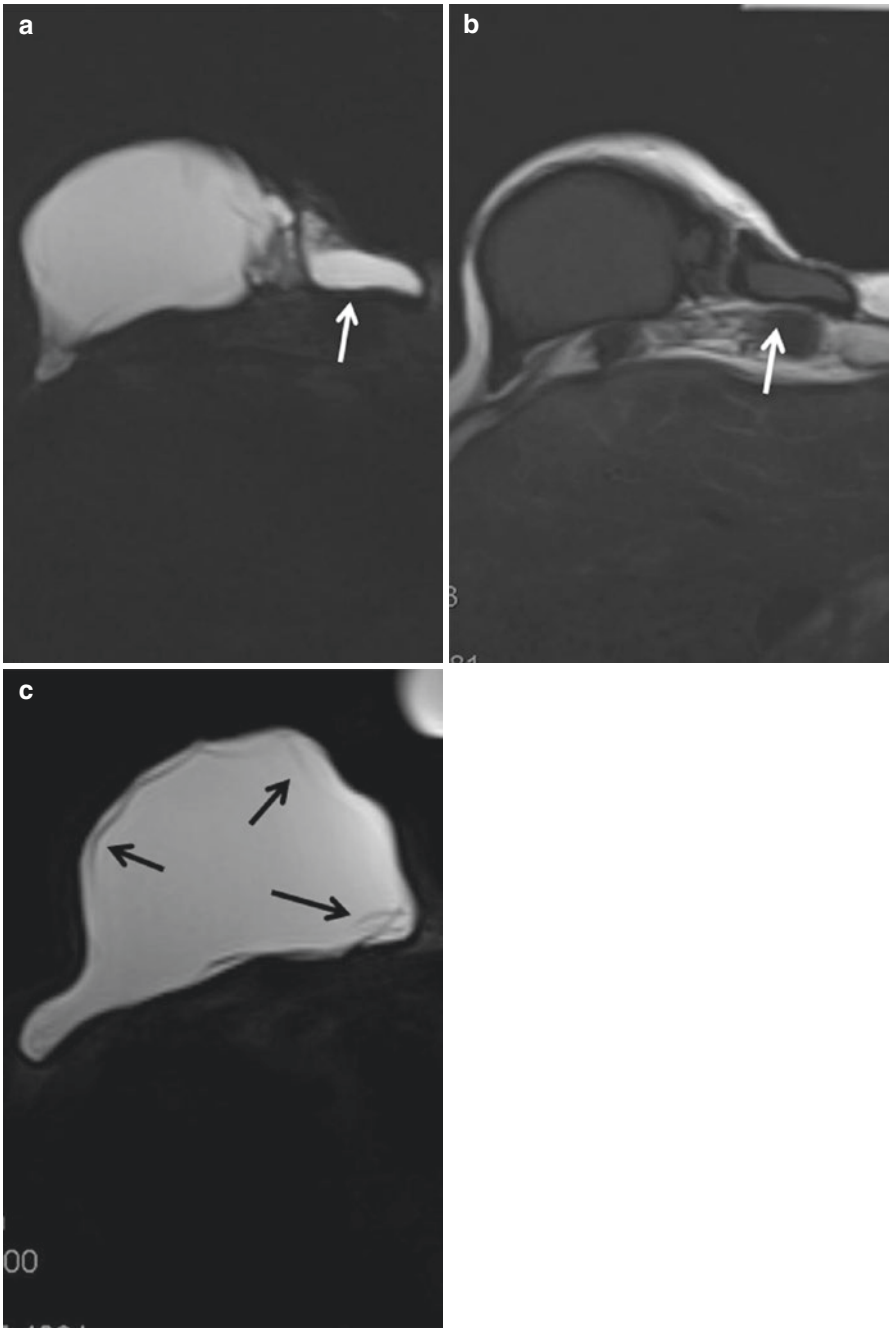

Fig. 6.9 (**a**) Axial water suppressed sequence demonstrates free silicone at the medial aspect of the implant, consistent with extracapsular rupture (*white arrow*). (**b**) This also seen on axial silicone suppression sequence (*white arrow*). (**c**) The implant also demonstrates intrcapsular rupture with multiple curvilinear hypointense lines seen on this axial water suppressed image (*black arrows*)

Another common pitfall occurs when small amounts of silicone oil osmotically transgress the intact elastomer shell and accumulate between the fibrous capsule and shell. Occasionally, because the oils maintain silicone signal, the accumulation of such oils can cause confusion with small inverted-loop appearances.

Sometimes it can be difficult to differentiate between a single lumen implant with intracapsular rupture and a double-lumen implant where no saline was placed in the outer lumen or the outer lumen saline deflated previously. In this situation, medical records and old mammograms can be very useful. Additionally, high resolution implant imaging can sometimes identify both the inner and outer lumen shells [19].

An additional, less frequently encountered pitfall occurs when extracapsular soft-tissue silicone is seen as an enhancing mass within the breast, which can be confused with malignancy. However, silicone granulomas and silicone fluid collections usually enhance with benign enhancement characteristics, and implant specific imaging sequences (silicone-sensitive and silicone-saturated) can also help resolve this dilemma. Breast MRI can be particularly helpful in women with free silicone injections. Mammography and ultrasound have limited sensitivity in this population, but a silicone suppression sequence may be employed in conjunction with a contrast-enhanced study in order to differentiate between concerning lesions and silicone (Fig. 6.10).

6.9.1 Implants and Breast Cancer

There is no direct association between breast implants and breast cancer; however as patients with breast implants age, there is an anticipated increase in the number of breast cancers seen in women with augmented breasts [20]. While mammography is still the primary imaging technique for detecting breast cancer in women with implants, given the decreased sensitivity of screening mammography in this population, there is an increased interest in using MRI to detect breast cancer. Patients who are high-risk will be candidates for dynamic contrast enhanced studies, which involves injecting contrast material and obtaining multiple T1-weighted sequences before and at three time points after the injection (Figs. 6.11 and 6.12).

Studies have examined the features of breast cancers detected in women with implants, and have shown that there is a higher rate of palpable, invasive cancers in women with implants. Importantly however, the stage distribution of cancers in women with implants is similar to screening populations [6]. Mango et al. characterized the MRI features of breast carcinomas detected in the augmented breast [21]. The authors found that the majority of cancers (63 %) appeared as irregular, non-circumscribed, enhancing masses. Most commonly tumors were located in the upper outer quadrant of the breast and frequently (37 % of the time), the tumor abutted the implant. Tumor spread along the implant contour was more likely to be seen with subglandular implants than with subpectoral implants. There was no signifi-

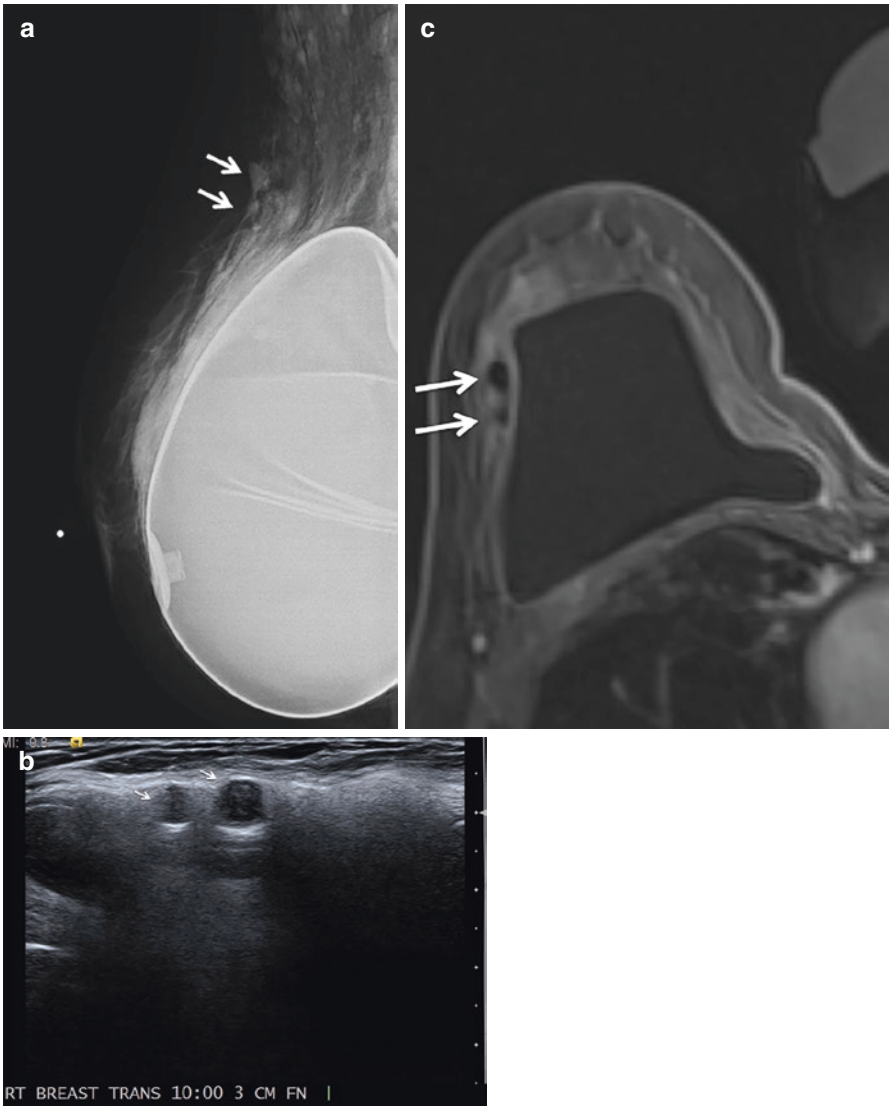

Fig. 6.10 (**a**) 46 year-old woman with previous history of ruptured silicone implant and current saline implants. Right mediolateral oblique mammogram demonstrates the saline implant. At the superior aspect of the breast, abutting the implant, are two asymmetries (*white arrows*). (**b**) Directed ultrasound demonstrates two round circumscribed hypoechoic masses abutting the implant and correlating with mammography (*white arrows*). (**c**) Breast MRI was performed with both contrast-enhanced and implant evaluation sequences. Axial post-contrast T1 demonstrates two adjacent non-enhancing circumscribed masses (*white arrows*) which correlate with mammographic and sonographic findings. (**d**, **e**) The masses follow silicone signal on water suppression and silicone suppression sequences (*white arrows*) and are consistent with silicone granulomas

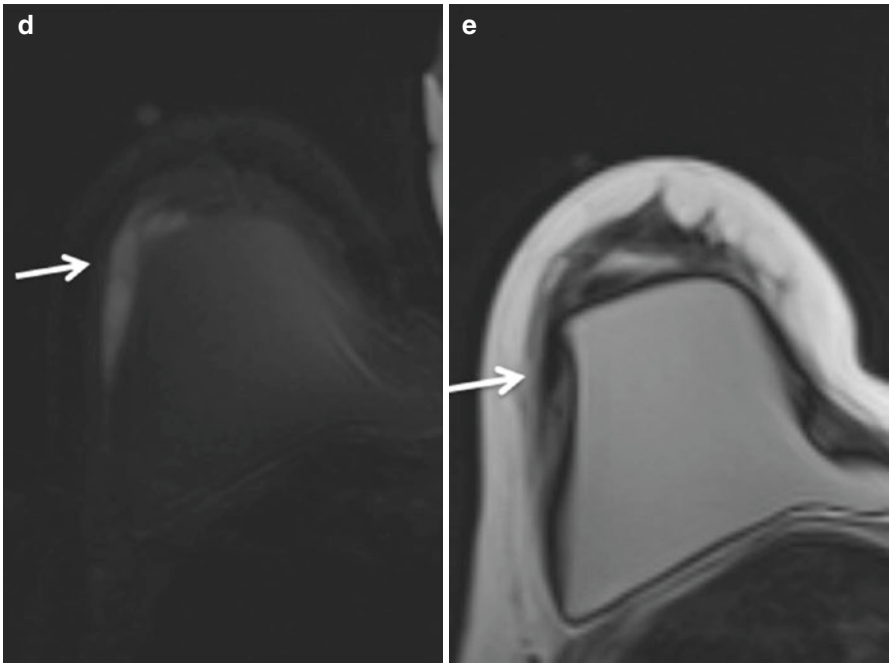

Fig. 6.10 (continued)

cant difference between implant position and lesion morphology or tumor size. In this study, MRI identified mammographically and sonographically occult cancer in 30 % of cases and identified patients with otherwise occult multifocal disease (7 %) and multicentric disease (22 %). While further studies are needed, the results of this study suggest that MRI should be considered to assess extent of disease in women with implants and newly diagnosed cancer before surgery.

For breast cancer patients treated with mastectomy, there is no significant difference in the rate of cancer recurrence in augmented versus non-augmented breasts. A small series has shown MR imaging to be superior to physical exam and mammography for the detection of recurrent cancer in postmastectomy patients with implants, especially when tumor was close to the chest wall [22].

A promising alternative to diagnose breast cancer without the injection of contrast has been proposed using diffusion-weighted MR imaging (DWI) [23]. While still in the process of being validated, the main concept behind DWI is that the high cellular density of proliferating cancers will cause increased restricted diffusion and thus the calculated apparent diffusion coefficient (ADC) maps will be lower when compared with normal fibroglandular tissue or benign lesions. Performing screening MRI based on diffusion measurements would require a fast technique, with reduced sensitivity to motion artifact. Recently, in 2015 Solomon et al evaluated the usefulness of diffusion-weighted spatiotemporally encoded (SPEN) MRI sequences to obtain ADC maps of normal fibroglandular

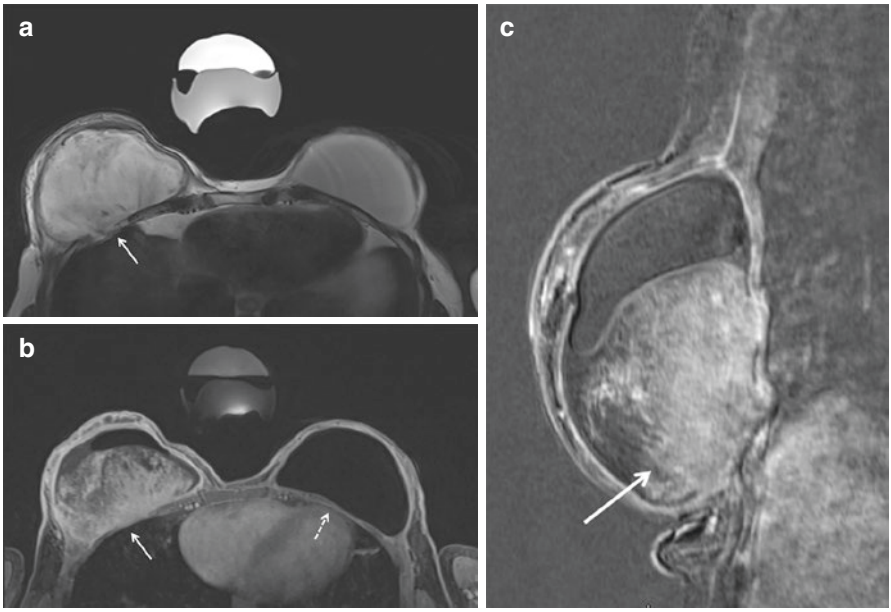

Fig. 6.11 (**a**) 45-year-old woman with history of left mastectomy for LCIS and bilateral silicone implant reconstruction with enlarging right breast mass. Axial nonsuppressed T2 MRI image demonstrates a large heterogeneous right breast mass (*white arrow*) which invades the chest wall and displaces the silicone implant. Note normal appearance of the silicone implant on the left (*white dashed arrow*). Axial (**b**) and sagittal (**c**) post-contrast T1-VIBE with fat-saturation MRI images demonstrates this mass is heterogeneously enhancing (*white arrow* on each figure). Final pathology revealed aggressive fibromatosis

tissue in the presence of silicone implants in seven healthy volunteers [24]. They found that despite dominant signal from silicone implants, they were able to obtain reliable ADC maps of fibroglandular tissue. While additional studies with more patients are needed to validate these results, the findings present promising new MRI screening possibilities for the future.

6.9.2 Other MRI Findings in Patients with Implants

Postoperative seromas are expected following implantation; however the development of a large fluid collection beyond the immediate postoperative period raises the possibility of infection. Occasionally fluid collections are noted following viral syndromes and aspiration of the fluid does not demonstrate a causative organism [25].

Recently a relationship has been described between breast silicone implants and the development of anaplastic large cell lymphoma. This usually manifests as an ill-defined mass, however one of the unexpected imaging findings of anaplastic

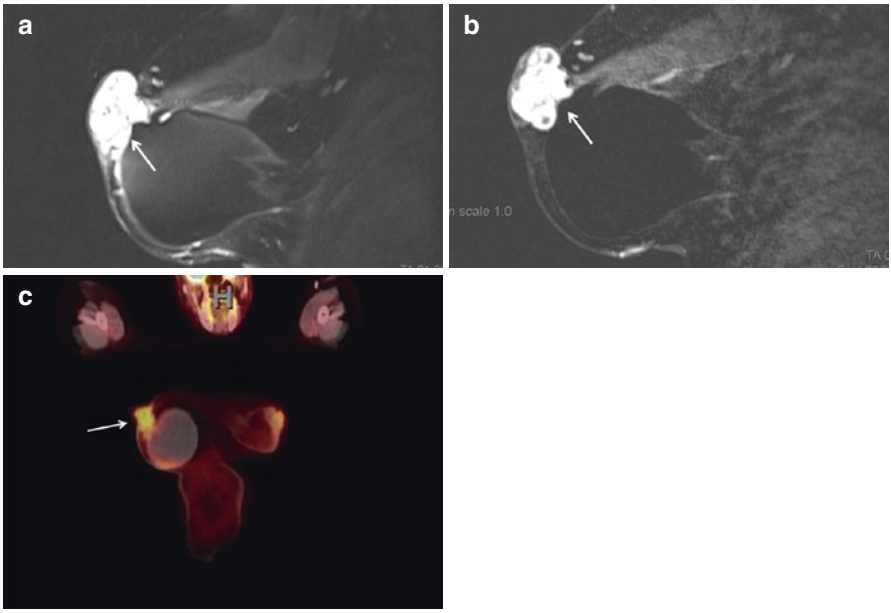

Fig. 6.12 50-year-old woman with a history of benign right phyllodes tumor 3 years ago and status post bilateral mastectomies and reconstruction with silicone implants presents with a new right periareolar mass. (**a**) T2 weighted sagittal MRI image demonstrates T2 hyperintense exophytic mass correlating with palpable lump abutting the superior aspect of the implant (*white arrow*). (**b**) The enhancing mass (*white arrow*) demonstrates Type 1 (persistent) enhancement. (**c**) The mass is FDG-avid on PET-CT (*white arrow*). Ultrasound-guided biopsy demonstrated recurrent phyllodes

large cell lymphoma is that it can mimic a seroma or fluid collection related to infection or post-viral syndrome [26].

After placement of silicone implants, nonspecific inflammation or silicone migration can cause axillary and internal mammary lymph nodes to enlarge. The differential diagnosis of enlarged lymph nodes includes recurrent breast cancer and second primary nodal metastases. In a study of 923 women with breast cancer and silicone implants by Sutton et al in 2015, the authors concluded that intramammary lymph nodes identified on MRI after oncoplastic surgery for breast cancer were overwhelmingly more likely to be benign than malignant [27] (Fig. 6.13).

6.10 Conclusions

Breast implant magnetic resonance imaging is the primary modality used to evaluate implant integrity and to determine the relationship of breast implants to any breast lesions that may be present. Much existing data supports the utility of MRI in

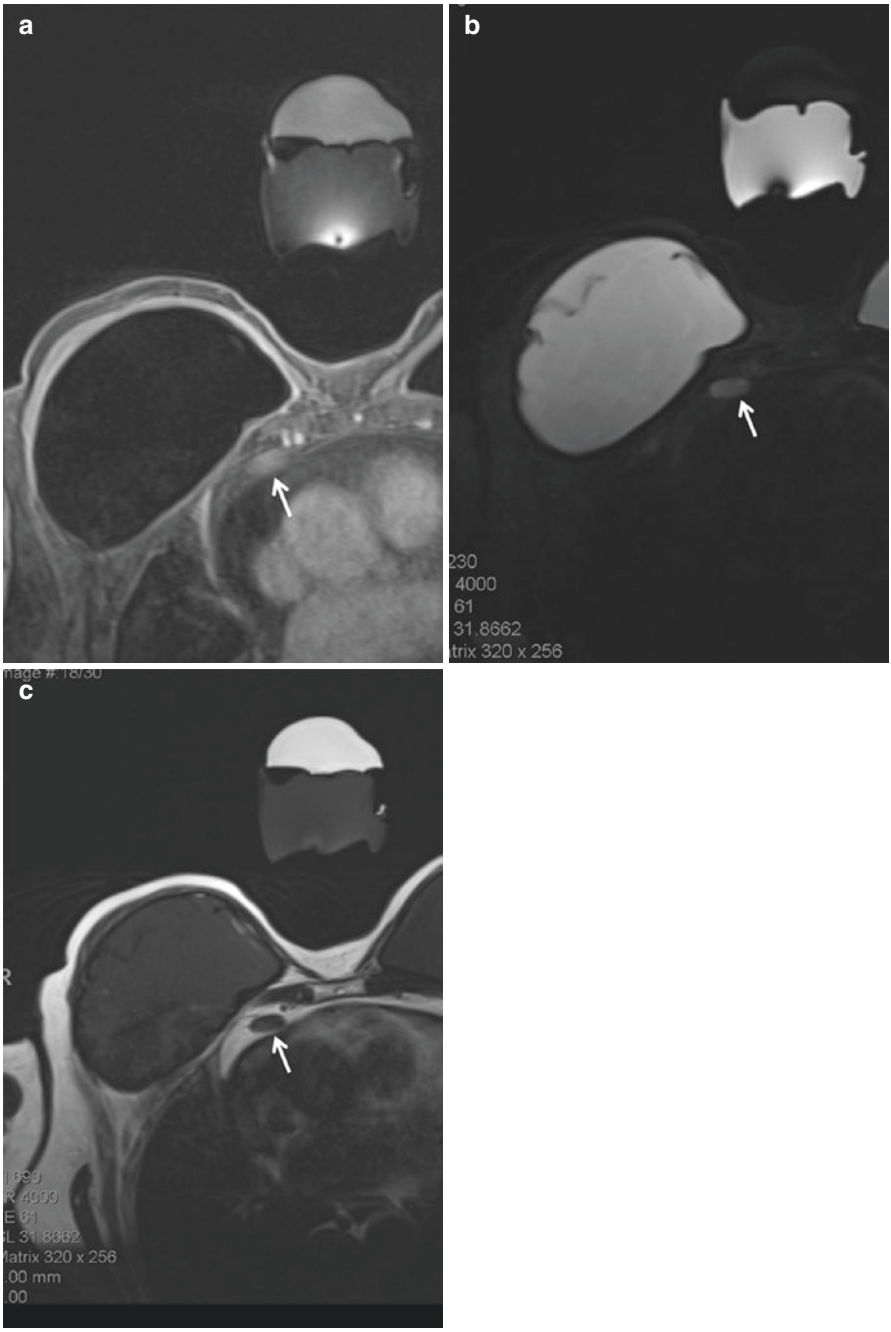

Fig. 6.13 75-year-old woman with history of remote left breast cancer status post bilateral mastectomies and multiple silicone implant revisions. Breast MRI demonstrates an enlarged enhancing anterior mediastinal lymph node (*white arrow*) seen on delayed post contrast T1 weighted axial image (**a**). The lymph node follows silicone signal on water suppression (*white arrow*) (**b**) and silicone suppression (*white arrow*) (**c**) sequences

evaluating women with breast implants. Noncontrast MRI utilizes sequences that are designed to separate water, silicone and fat to evaluate the internal implant structure and assess for extracapsular silicone. Contrast enhanced MRI has been shown to be a useful adjunct to mammography, which has limited sensitivity in detecting breast cancer in women with breast implants. The role of MRI in screening asymptomatic women with breast implants remains to be determined, and future directions include utilizing diffusion weighted imaging, avoiding the need for contrast enhancement.

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