RM study protocol in the evaluation of breast implants

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Abstract

MRI of the breast is an up-to-date and correct technique that plays a key role. Recent advances have shown that breast MRI is not only capable of detecting breast cancer, but can also visualise and depict the breast vasculature very precisely. It makes a significant diagnostic contribution to the correct framing of the disease and its appropriate management. It is the most effective technique for the follow-up of patients who have undergone oncological breast surgery (reconstructive mastoplasty) and for the evaluation of the status of breast implants since, through dedicated sequences that enhance the different signal intensities between adipose tissue, water and silicone gel, it allows obtaining useful images for the evaluation of any intra- or extra-prosthetic rupture.

Introduction

Since breast MRI became established in clinical practice, there has been a progressive diffusion of it, associated with the widening of clinical indications: it is a highly sensitive technique that allows accurate diagnosis, evaluation and characterisation of breast lesions and in the assessment of breast implants. Being a multiplanar and multi-parametric technique, MRI allows images to be acquired in different planes (coronal, axial, sagital and oblique) and to use multiple reference parameters, such as proton density, DWI sequences, fat suppression. The most commonly used breast implant models, both in oncological breast surgery (reconstructive mastoplasty) and in surgical procedures to increase the volume and change the shape of the breasts (breast augmentation), vary in shape, size and materials.

In particular, breast implants can be single or double chamber. The envelope, or prosthetic membrane, can have a smooth or textured surface (i.e., formed by microscopic villi that reduce the risk of capsule contracture).

Prostheses can be filled with different materials: in the single-chamber variety, silicone gel or saline is generally used; in the double-chamber variety, both are used; they can be implanted in a pocket between the mammary gland and the pectoralis major muscle (retro-glandular implant), behind the pectoralis major muscle (submuscular implant) or partly below the pectoralis muscle and partly retro-glandular (dual plane). (Fig. 1)

This study, which is descriptive in nature, is going to focus on the MRI study protocol for evaluating breast implants, explaining in particular the sequences and the reason for their use.

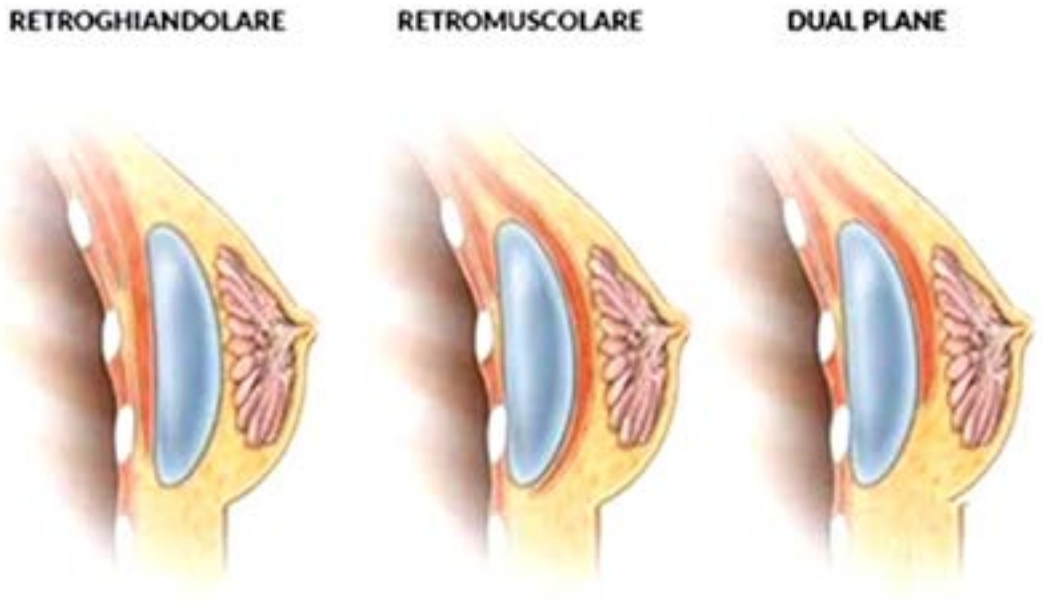

Fig.1 *Anatomical image of breast implant placement.*

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Equipment and patient positioning

Adequate technical instrumentation is required for breast MRI studies, in particular a magnetic field of at least 1.5 T with appropriate hardware and software combined with a high-performance gradient system (> 20 mT/m), dedicated bilateral coils for breast studies and an automatic injector connected to the patient via a special needle-cannula.

Dedicated coils for breast studies (Fig. 2) have two bilateral holes (cups), inside which the breasts can be inserted for signal reception only, and a headrest on which the patient places her forehead. They make it possible to simultaneously study both breasts and obtain images of excellent quality, with a high signal-to-noise ratio and signal homogeneity over the entire extension of the breast. These coils also allow biopsies and preoperative centring to be performed.

Fig. 2 *Dedicated MRI coil for the study of breasts.*

The patient is made to lie prone on the MRI couch, inviting her to insert her breasts into the holder where the coils are housed. The arms are brought above the head and stretched so that the axillary cord, the pectoralis muscle and the breast itself are stretched as best as possible. The head is placed in the headrest. Centring takes place at the level of the sixth dorsal vertebra parallel to the breast.

Study Protocol: MRI

starts with the acquisition in the three planes (axial, coronal and sagittal) of a fast T1-weighted reference sequence (survey) that allows the visualisation of the anatomical region to be studied and enables the correct orientation of the sequence planes; this is followed by the refscan useful for the homogenisation of the magnetic field prior to the acquisition of the sequences.

The silicone elastomer prosthetic membrane and the fibrous capsule, which forms on the external surface of the prosthesis as the body's immune reaction to the foreign body, both present low signal in the MRI images and appear hypointense in T1 and T2 sequences.

In the event of intracapsular rupture of the prosthesis, due to the collapse of the prosthesis wall, it is possible to observe hypointense lines in the silicone gel in the T2 sequence, generally referred to as 'sign tongues' (Fig. 3)

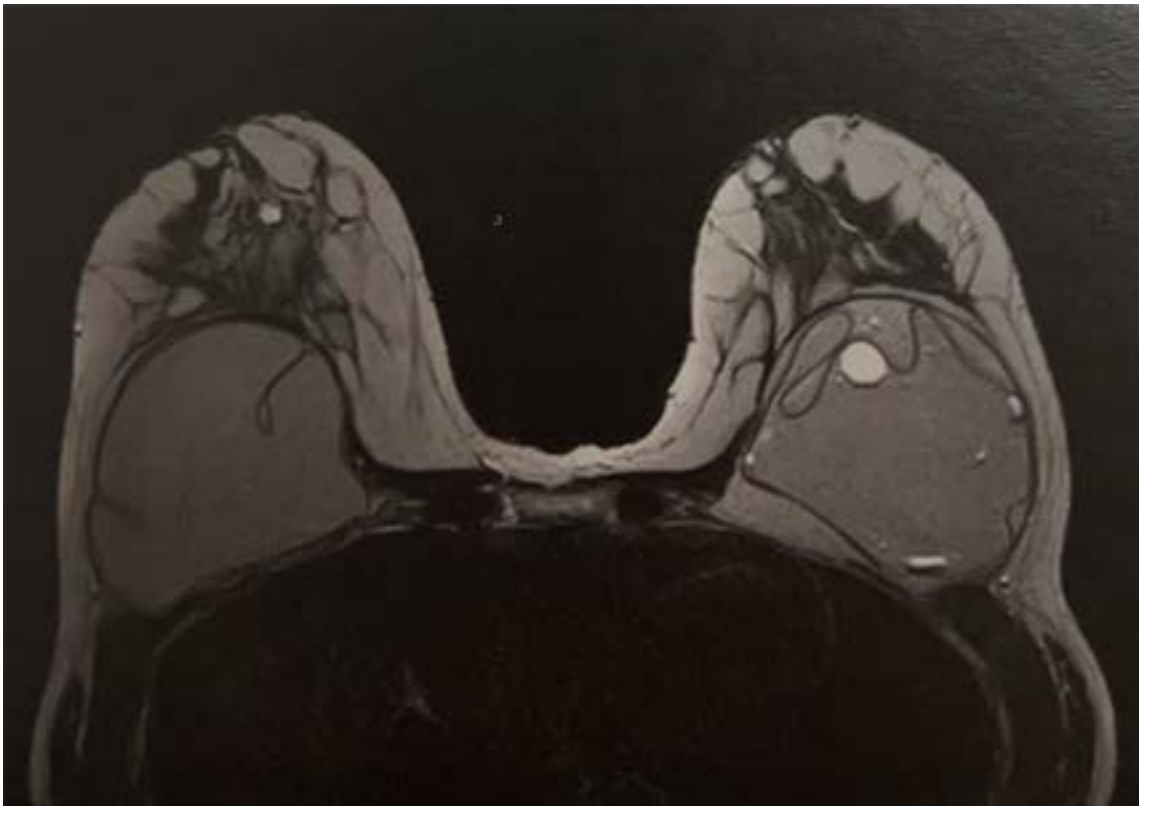

Fig. 3 *T2W sequence: collapsed prosthetic shell (sign tongues).*

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MRI examination for the evaluation of breast implants may require the use of contrast medium in the case of follow-up after oncological breast surgery (reconstructive mastoplasty) but, above all, it requires sequences that enhance the different signal intensities between fat tissue, water and silicone gel. This difference is due to the fact that protons in water, fat and silicone have different chemical shifts. Silicone has a resonance frequency about 100 Hz lower than that of fat and about 320 Hz lower than that of water. It follows that gels and fat have a very similar signal to each other (medium-high in T1 and high in T2): therefore, during sequence acquisition, suppression of the fat signal will enhance the signal from the silicone. This approach is particularly useful in the case of capsule rupture with silicone leaking into the glandular tissue. Silicone and water, on the other hand, have very similar hyperintense signal in the T2 sequences: in this case, water suppression can be used in order to differentiate the different components of the prosthesis and to diagnose a possible rupture of the double-chambered prosthesis (given the presence of physiological and silicone gel). In T1 sequences, skin, fibroghiandular tissue, lymph nodes and muscle present a hypointense signal with respect to the hyperintensity of fat; the mammary gland therefore presents a mixed signal: low intensity of fibroghiandular tissue surrounded by hyperintense fat tissue. In the T2 sequences, on the other hand, the fibroghiandular tissue presents a mixed signal that is more hyperintense than the muscle, but markedly lower than the vascular or liquid-containing structures; the fat, if not suppressed, is hyperintense.

Dedicated sequences:

- ***Silicon-only***: It is a T2 sequence characterised by a combination of SPAIR pulses (useful for suppressing the water signal) and STIR pulses (useful for suppressing the fat signal) that allows the visualisation of silicone implants (Fig. 4);

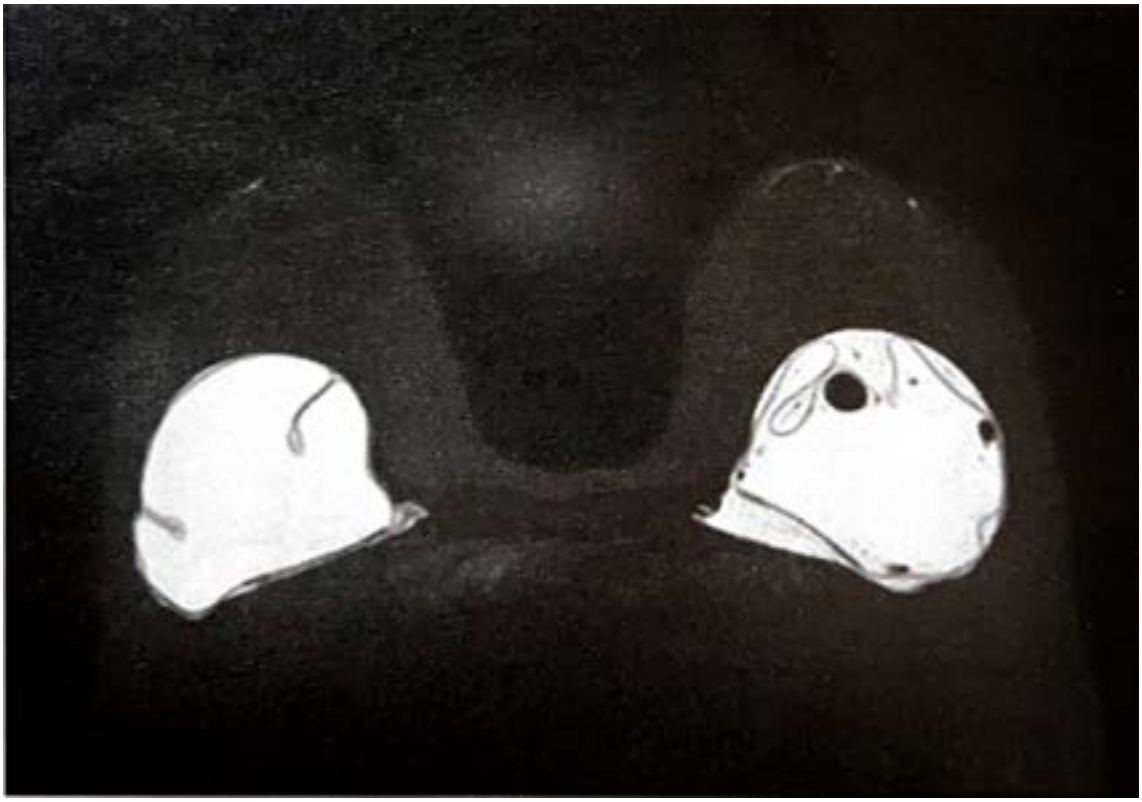

Fig. 4 *T2 image silicon-only.*

- ***Silicon-suppression***: Gradient Echo T1 sequence using SPAIR pulses capable of suppressing the fat and silicone signal (Fig. 5);
- ***Dynamic T1 GE***: It is a fat-suppression gradient echo T1 sequence, fundamental for studying glandular parenchyma. It consists of several acquisitions over time (dynamic), one of which is pre-contrast and the rest post-contrast. The contrast medium is injected in bolus, through the automatic injector, between the end of the baseline and the beginning of the first post-contrast sequence. Of fundamental importance is post-processing, which enables enhancement

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Fig. 5 *GE T1 image silicon-suppression.*

curves, image subtraction (the pre-contrast basal image is subtracted from each individual post-contrast image in order to assess the behaviour of the contrast medium over time; Fig. 6), MIP reconstructions (Fig. 7) and MPR.

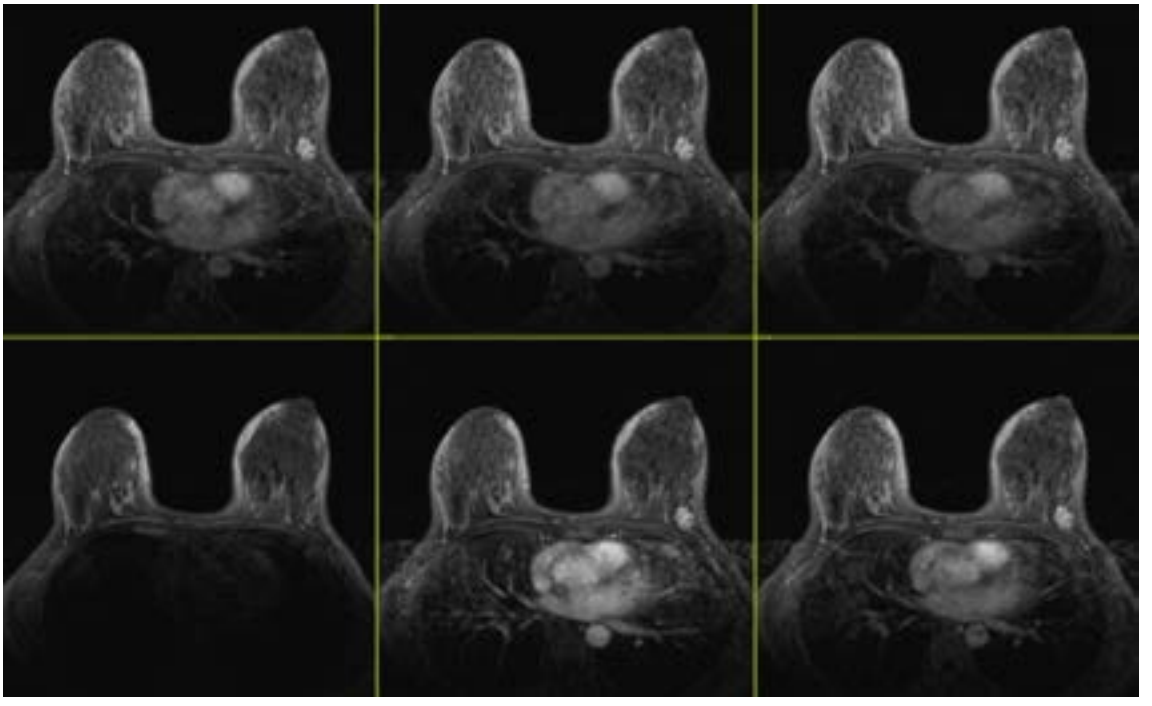

Fig. 6 *Dynamic T1 GE: set of dynamic images showing the progress of the contrast medium.*

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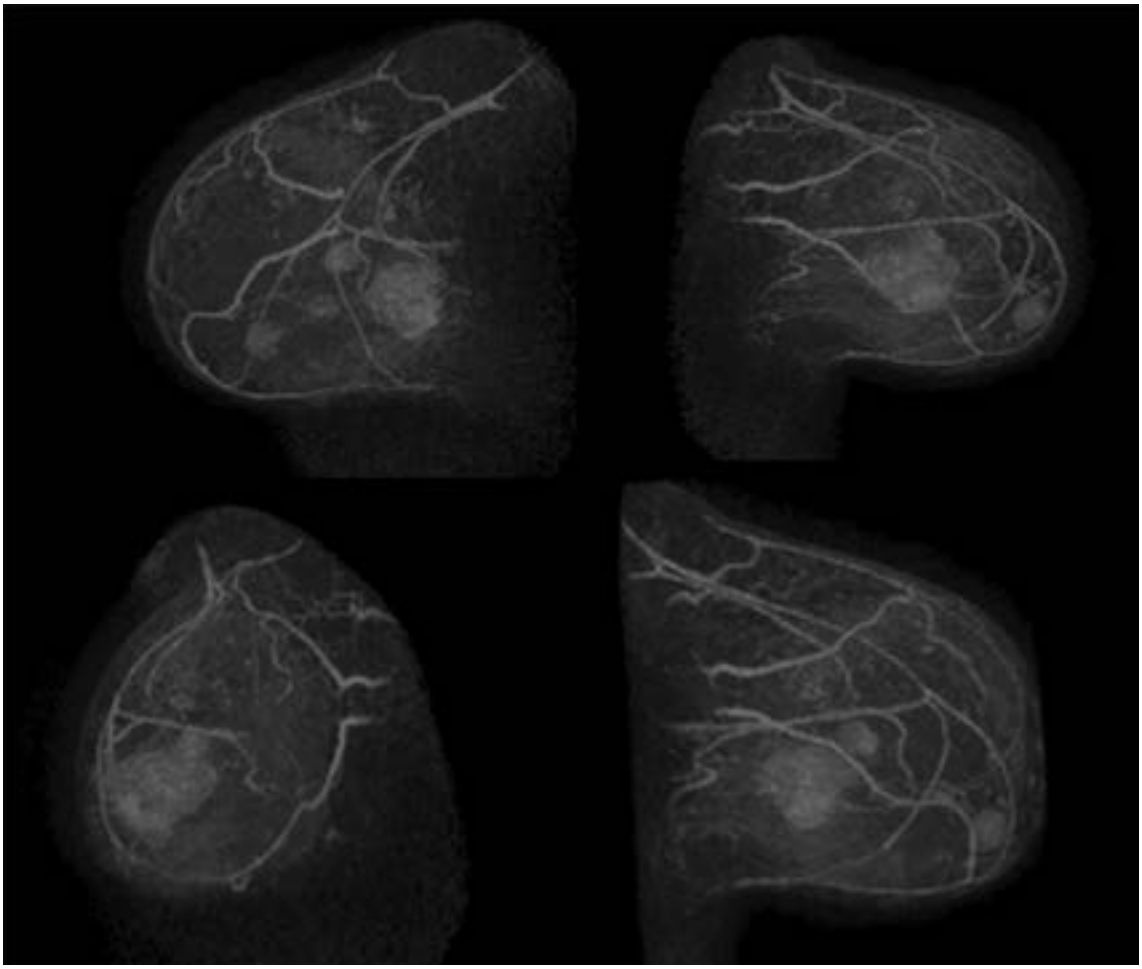

Fig. 7 *Post-contrast MIP reconstruction.*

Conclusions

Since breast MRI became established in clinical practice, there has been a progressive diffusion of it, associated with the widening of clinical indications: it is a highly sensitive technique that allows accurate diagnosis, evaluation and characterisation of breast lesions and in the assessment of breast implants. The main advantages for patients undergoing breast MRI are: high sensitivity in identifying changes in breast tissue and/or implants; multiplanar imaging; absence of ionising radiation; and the possibility of being able to perform MRI-guided biopsies. The main problems that patients may experience are: uncomfortable position; feeling claustrophobic or discomfort caused by anxiety and/or stress. However, these problems could be solved by establishing a relationship of mutual trust between patients and health professionals through continuous assistance throughout the investigation, from patient acceptance to the conclusion of the diagnostic examination.

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