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CASE REPORT
Breast

Artifacts on Magnetic Resonance Imaging from Electronic Identification Enablement in Silicone Gel Implants Are Not Negligible

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Summary: Breast implants filled with silicone gel are used worldwide for cosmetic reasons, or breast reconstruction following risk-reducing or therapeutic mastectomy. The importance of identifiable implants is undeniable. A recent development has been the labeling of the implants with a radio-frequency device micro responder chip (RFID). We examined a patient with silicone implants containing RFID chips with magnetic resonance imaging and were surprised by the artifacts caused by the RFID chip. We raise the question if the benefits of RFID-labeled silicone implants outweigh the drawbacks of magnetic resonance artifacts caused by the RFID chip itself. *(Plast Reconstr Surg Glob Open 2021;9:e3941; doi: 10.1097/GOX.0000000000003941; Published online 22 November 2021.)*

Patients with silicone filled breast implants will likely need radiological breast imaging several times during their lifespan. The lifetime risk of developing breast cancer in the western world is 12%. The risk might be significantly higher for women with a positive family or personal history of breast cancer or genetic predisposition for breast cancer. Magnetic resonance imaging (MRI) is the gold-standard diagnostic tool for detecting and assessing breast lesions in women with breast implants, and as such, image quality is of utmost importance.

CASE REPORT

A 40-year-old female patient detected a palpable lump in the upper outer quadrant of her left breast in July 2020. Before this, she was healthy. The patient underwent bilateral breast augmentation with silicone implants placed in the submuscular plane for cosmetic reasons 18 years ago. Mammography and ultrasound of both breasts were performed at a private institute. Corresponding to the palpable mass, a lobulated, circumscribed hypoecogenic mass was found on ultrasound. The lesion was not BI-RADS classified. Cytology from ultrasound-guided fine needle aspiration revealed no typical malignant breast epithelium cells. Due to the age of the silicone implants, a replacement of the old implants was planned simultaneously with removal of the palpable mass. The new implants were placed in the same submuscular envelope and were of Motiva SmoothSilk/SilkSurface (MSS) implant type (Establishment Labs Holdings, Alajuela, Costa Rica) (Fig. 1). However, histology revealed a 16 mm infiltrative carcinoma of no special type pT1cN2a (4/9) M0 grade 3, surrounded by ductal carcinoma in situ grade 3, estrogen and progesterone receptor negative, ERBB2 (formerly HER2) positive, and the patient was referred to our hospital. During staging of the patient, an MRI of the liver was planned on a 3T Philips Ingenia MRI system (Philips, Best, the Netherlands). Surprisingly, there were large artifacts arising from the posterior surface of the silicone implants, which compromised the image quality of the scout images of the liver (Figs. 2, 3). An examination of the liver was then performed on a 1.5 T MRI machine where the artifacts were minimized, after slight sequence customization.

DISCUSSION

The MSS implants contain a radio-frequency device micro responder (RFID-M) (JAMM Technologies, Minneapolis Minn.) integrated within the posterior inner surface of the implant.[1,2] The RFID-M measures 2.1 × 9 mm (Fig. 2). With the RFID-M, it is possible to provide information about the implants through a 15-digit electronic serial

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Fig. 1. Motiva SmoothSilk/SilkSurface implant type (Establishment Labs Holdings, Alajuela, Costa Rica). The radio-frequency device micro responder (RFID-M) (JAMM Technologies, Minneapolis Minn.) is integrated in the posterior inner surface of the implant.

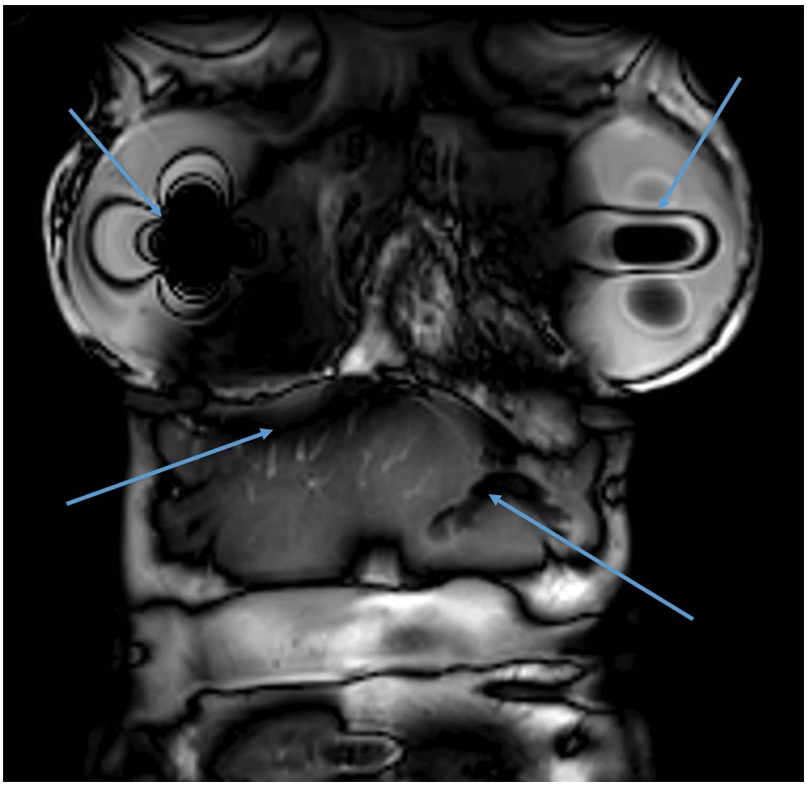

Fig. 2. Survey from Philips Ingenia 3.0T scanned with dStream anterior coil and posterior coil. bFFE-sequence in the coronal plane (FOV 450 mm, TR: 3.02 ms, TE: 1.51 ms, slice thickness 10 mm, 20 slices, matrix: 256 × 224, BW 1924 Hz, flip angle 60 degree, acquisition time 15 s. The survey shows major artifacts over the silicone implants (arrows). bFFE, balanced Fast Field Echo; BW, bandwidth; FOV, field of view; TR, repetition time; TE, echo time. The two upper arrows point at the artifacts from the RFID-Ms in the silicone prosthesis. The two arrows below show more distant artifacts caused by the RFID-Ms, leading to image quality impairment of the liver parenchyma.

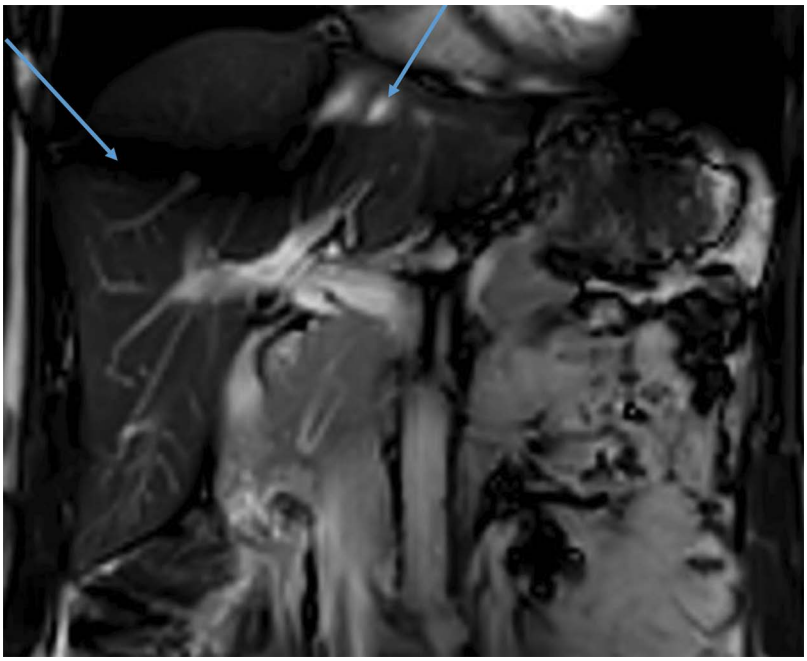

Fig. 3. Survey in the coronal plane from the liver. Equipment and acquisition parameters are the same as in Figure 2. Artifacts from the RFID-M are also visible over the liver parenchyma (arrows).

number, when scanned by a hand-held reader.[1,2] Traceability of breast implants by using a unique device identification is mandatory in both Europe and in the United States.[3,4] Unique device identification is commonly a serial number, that links the specific implant to production date, expiration date, serial number, and batch number. According to legislation, the implants must be marked by a unique device identification, with at least a physical implant card and registered in the electronic patient record.[3,4] RFID-based tracking of the medical implant therefore represents a higher level of tracing than legally obligated. RFID is not a new technique, and has been used widely (ie, in veterinary medicine) for decades.[5] The RFID-M inherently contains magnetic metal, and due to the strong magnetic field in the MRI scanner, the metal unfortunately causes artifacts on the MRIs. One prior study on MRI artifacts caused by the RFID-M in the MSS implants asserts that the possible harm of artifacts is magnitudes smaller than the benefits of traceable implants.[6] A study assessing safety and image quality of MRI with RFID-tags showed image distortion up to 8 cm from the RFID on a 1.5 T scanner. Further, the study suggests not to use gradient echo sequences with a present RFID-tag.[3] Another study measured artifacts in 42.9 cm^3 on T1-weighted MRIs and 60.5 cm^3 on T2-weighted images, which are substantial volumes of tissue.[7]

Traceability of implants is important, however, in our patient, the artifacts were not negligible and caused problematic artifacts in the liver, which is not located adjacent to the chip.[8,9] We are aware of the possibility to use a weaker field strength, which we performed on this patient, and adjust the MRI sequences to be more robust against metal artifacts. Nonetheless, this requires knowledge and the availability of MRI machines that vary in magnetic field strength, and we are concerned about the detection and characterization of pathology in the breast near the RFID-M where the artifacts are expected to be even larger compared with the artifacts in the liver in our patient. Nelson and coauthors state that the cancer detection rate improves in the area of artifacts if additional diagnostic modalities like ultrasound are used, but the tissue located dorsal to the implants is often suboptimally accessible with ultrasound and MRI is the imaging method of choice.[6,8-11] Implants may also rotate, and the artifacts will subsequently cover more breast tissue compared with the dorsal position of the RFID-M.[2] We must not forget that breast implants have become common in many parts of the world, and a substantial number of the patients with an increased risk of developing breast cancer choose to receive silicone implants. It is, in our opinion, of uttermost importance that the implants do not complicate early detection of cancer unnecessarily.[12] Artifacts from the RFID-M in the sequences necessary for cancer detection have only been studied in one single-institution study on one MRI scanner with a 1.5 T field strength. Even on a 1.5 T scanner, the artifact volumes were substantial, and several different sequences are interesting to assess for a more complete picture of the impact of the artifacts caused by RFID-M.[7]

We find it worthwhile to discuss the potential drawbacks of compromised MRI quality caused by RFID-M. Even if minimizing the artifacts and their effects is possible, MRI is such an important diagnostic tool that it should be imperative to find solutions for tracing implants that do not interfere with magnetism or with other imaging modalities used in breast and cancer diagnostics.[11,12] If the use of RFID-M is desired, systematic studies that evaluate the artifacts from the RFID regarding size, different

commonly used sequences, different MRI scanners, and field strengths should be conducted to have a better understanding of potential risks regarding cancer diagnostics caused by MRI artifacts in comparison with the benefits provided by RFID-M tagged implants.

CONCLUSIONS

In our opinion, RFID-M used in some breast implants is not sufficiently evaluated regarding artifacts on MRI. There is a need for studies evaluating the impact of the chips on the MRI quality in women who already have implants with RFID-M.

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