Magnetic resonance imaging (MRI) findings of oxidised regenerated cellulose in breast cancer surgery: a five-year experience

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Aims and objectives

Conservative breast surgery followed by postoperative radiation therapy has become the gold standard treatment for early stage breast cancer (1-4).

Recently some surgeons have focused their attention on oncoplastic procedures, which combine principles of surgical oncology with those of reconstructive surgery, allowing a more radical local tumor excision, which potentially reduces margin involvement and local recurrence, while achieving an acceptable cosmetic result (5-7).

In our Institution, over the last 5 years, surgeons started to use oxidized regenerate cellulose (ORC), (Tabotamp fibrillar®, Johnson & Johnson; Ethicon, New Brunswick, NJ, USA) which is a sterile absorbable material, used originally in intra-abdominal or retroperitoneal surgical procedures, in order to obtain local hemostasis (8 and 12).

ORC is a bioadsorbable topical hemostatic agent used with increasing frequency in various surgical procedures, when control of bleeding can be difficult. It was used originally in intra-abdominal or retroperitoneal surgical procedures, in order to obtain local hemostasis and it was first proposed as a filling material for volume defects after breast surgery in 2003 (11-14).

When applied in the surgical cavity, ORC swells into a gelatinous brown-black mass, which allows local control of bleeding, reduction of risk of post-operative infections, thus combining the oncological radicality with the aesthetic results; on the other hand this procedure could induce changes in radiological appearance of surgical scar (8-12).

Because patients undergoing conservative breast surgery need early radiological controls in the postoperative period and subsequent follow-up over time, radiologists should be familiar with the imaging features specific of ORC, to avoid erroneous diagnoses of recurrent disease (23).

In literature, some studies have described the radiographic, CT and ultrasound features of ORC when it is used in breast surgery (13, 16-17), while there are only generic studies for MR imaging, in which ORC is mainly used in intra-abdominal surgery, but it is not described in the literature the MRI appearance of ORC after conservative breast surgery (18).

The aim of our study was to describe the MRI findings in patients undergoing conservative breast surgery in which has been used the ORC into the surgical cavity.
Methods and materials

Patients Selection

We retrospectively searched our institutional electronic database in order to identify all patients who underwent breast conserving surgery with ORC implantation in the surgical cavity and referred for breast MRI in the suspicion of ipsilateral or contralateral cancer recurrence or for evaluation of new suspicious lesions detected during mammographic or sonographic follow-up examinations. Therefore, we obtained the data from 39 patients (mean age 52 yo, range 20-91) who underwent MRI in our department between January 2009 to March 2013, for a total of 51 MR examinations. The protocol of the study was approved by the institutional ethics committee. Informed consent, including potential risks and benefits of the procedure, was obtained from all patients. Although the recall and data analysis were done retrospectively, the patient database was assembled prospectively.

Breast MRI technique

MRI was performed using a 1.5-T scanner 23 mT/m gradient intensity (Signa Excite; GE Healthcare, Milwaukee, WI). Patients were placed in a prone position and examined using bilateral breast surface coils. MRI protocol was as follow:

- Ø **Short tau inversion recovery (STIR) axial sequence** (repetition time [TR] = 6000, echo time [TE] = 68, echo train length [ETL] = 17, inversion time [TI] = 150, bandwidth = 41-67, 320 x 320 matrix, thickness = 4 mm, 0 interval, field-of-view [FOV] = 32-34 cm, number of excitation (NEX) = 1-2, scan time = 4 minutes)

- Ø **Diffusion weighted imaging (DWI) axial sequence** (TR = 6725, TE = minutes, 128 x 128 matrix, thickness = 4 mm, 0 interval, FOV = 36 cm, NEX = 3, scan time = 2 minutes 40 seconds). DWI was acquired before dynamic sequences with a spin echo echo-planar imaging (EPI) sequence in the axial plane. Sensitizing diffusion gradients were applied sequentially in the x, y, and z directions with b values of 0 and 1000 sec/mm2.

- Ø **Three-dimensional (3D) fast spoiled gradient echo (FSPGR) fat saturation (fat sat) coronal sequence** (flip angle [FA] = 25 degrees, TR = 30 ms, TE = 5 ms, NEX = 1, thickness = 2-3 mm, 0 interval, 288 x 288 matrix, FOV = 32 cm, scan time for each sequence = 43 seconds, total scan time = 1 minute 36 seconds) before and 5 times after intravenous administration of 0.1 mmol/kg of gadopentetate dimeglumine. Contrast medium was injected with a 10-second timing delay into the antecubital vein with an 18- to 20-
gauge needle at a flow rate of 2 mL/s followed by a flush of 20 mL saline solution.

- Ø 3D FSPGR sagittal postcontrast fat-suppressed sequence (TR = 30, TE = 5, FA = 15 degrees, 238 x 238 matrix, thickness = 2-3 mm, 0 interval, FOV = 22-26 cm, NEX = 2, scan time = 3 minutes 44 seconds)

- Ø 3D FSPGR axial postcontrast fat-suppressed sequence (TR = 30, TE = 5, FA = 30 degrees, 512 x 256 matrix, thickness = 2-3 mm, 0 interval, FOV = 34-38 cm, NEX = 2, scan time = 3 minutes 24 seconds).

Acquisition time of this complete MRI protocol was 18-20 min. Dynamic images were transferred to a workstation (GE Healthcare®, AdvantageWindows 4.1 Milwaukee, WI, USA) and post-processed. Subtracted images, MIP (maximum intensity projection) and MPR (multi-planar reconstruction) functions were obtained and studied in cine loop. All images were subtracted and subtracted images of second post-contrast medium sequence were used for measurements. With a post-processing software that showed signal intensity changes in a given point of space in time (functool program), the region of interest (ROI) was selected and a dynamic curve was obtained.

**Interpretation of breast MRI**

All breast MRI were reviewed in consensus by two radiologists with more than 5-years-experience in breast MRI imaging. The presence or absence of signal abnormalities, mass like or non mass like enhancement, were evaluated on MRI images. Interpretation of the breast MR imaging was based on the following characteristics according to the American College of Radiology Breast Imaging Reporting and Data System MR imaging criteria:

- **shape** (round, oval, lobular or irregular);

- **margins** (smooth, irregular or spiculated);

- **internal enhancement** (homogeneous, heterogeneous, rim enhancement, dark internal septa, enhancing internal septa, or central enhancement).

We also analyzed the mass size, time-signal intensity curve pattern on dynamic contrast-enhanced images, and the ADC value derived from the ADC map.

To evaluate the enhancement pattern, the radiologist placed regions of interest (ROIs) that was demonstrative of the highest visual enhancement; then time-signal-intensity curves were constructed. Kinetic analysis was performed according to the Breast Imaging Reporting and Data System MR imaging guidelines to obtained three types of time-signal-
intensity curve patterns: the persistent pattern, the plateau pattern and the washout pattern.

For the ADC measurements, the radiologist manually placed ROIs within a given lesion; the size of ROI was never smaller than 40mm\(^2\) and typically ranged from 40 to 60mm\(^2\). Two ROIs were placed within the area corresponding to the area in which an ROI was placed for kinetic analysis. Thereafter, the average ADC of the two ROIs was selected. DWI sequence was considered positive when ADC <0.0014mm\(^2\)/s, negative when ADC>0.0014mm\(^2\)/s or in absence of hyperintensity areas (24).

In follow-up examinations, the temporal changes of the findings were also evaluated.

MRI was considered negative in the absence of areas of suspicious enhancement or signal abnormalities.

**Results**

In 29/51 MRI examinations, the radiologist described abnormal findings.

Three main MRI patterns were identified:

- Complex masses: hyperintense collections on STIR/T2 weighted (w) images with internal round or oval hypointense nodules without contrast enhancement after gadolinium (16 MRI examinations, 55%) (Figure 1 and 2)
- Completely hyperintense collections on STIR/T2w images (5 MRI examinations, 17%) (Figure 3)
- Completely hypointense lesions (8 MRI examinations, 28%) (Figure 4)

All detected lesions showed ring enhancement on T1w images obtained in the late phase of the dynamic study. (Figure 1-4)

DWI imaging showed 22 hyperintense lesions (76%) with ADC value >1.4 x 10\(^{-3}\) mm\(^2\)/sec and 7 hypointense lesions (24%).

In 4 cases (14%), focal areas or linear non-mass like enhancement were detected at the periphery of the surgical cavity; all these patients, in doubt of residual / recurrent disease, underwent to further follow-up examinations, and no areas of pathological enhancement as detected in subsequent MRI follow-up examinations, therefore the signal alterations, previously highlighted, were correctly interpreted as inflammatory reactions at the periphery of the surgical collections (Figure 5 and 6).
Images for this section:

**Fig. 1:** STIR axial sequence shows in the left breast, a hyperintense collection with an internal oval, hypointense nodule representing ORC named “ile flottante” by the authors (a) without enhancement after gadolinium in 3D-FSPGR axial postcontrast fat-suppressed sequence (b). This complex mass (pattern 1) shows ring enhancement on T1w axial and sagittal images obtained in the late phase of the dynamic study (b-c). US imaging shows a well-encapsulated hypo-isoechoic lesion with circumscribed margins with an internal hyperechoic nodule (d).
Fig. 2: STIR axial sequence shows in the left breast, a hyperintense collection with internal oval, heterogeneously hypointense nodules representing ORC (a) without enhancement after gadolinium in 3D-FSPGR axial postcontrast fat-suppressed sequence (b). This complex mass (pattern 1) shows ring enhancement on T1w axial and sagittal images obtained in the late phase of the dynamic study (b-c).
Fig. 3: STIR axial sequence and 3D-FSPGR axial postcontrast fat-suppressed sequence show in the left breast, a completely hyperintense lesion without solid internal nodules (pattern 2) (a-b), with a ring enhancement after gadolinium in 3D-FSPGR sagittal postcontrast fat-suppressed sequence (c). US imaging shows completely hypo-anechoic collections with thick walls (d).
Fig. 4: STIR axial sequence shows in the right breast, a completely hypointense lesions (pattern 3) representing fibrillar material (ORC) (a-b) with a ring enhancement after gadolinium in 3D-FSPGR sagittal postcontrast fat-suppressed sequence (c). US imaging shows completely hypo-anechoic collections with thick walls (d).
Fig. 5: In this patient, STIR axial sequence shows predominantly hyperintense collection with small, internal, round hypointense nodules in the left breast (a). 3D-FSPGR sagittal postcontrast fat-suppressed sequences reveal many areas of linear and focal, nodular-pseudonodular enhancement at the periphery of the lesion (b). The kinetic curve measured in different areas of enhancement shows a pattern of progressive-persistent enhancement (type 1) and this finding supports the hypothesis of benign post-surgical lesions instead of a residual-recurrent disease (c).
Fig. 6: In this patient, 3D-FSPGR axial postcontrast fat-suppressed sequences reveal many areas of focal, irregular enhancement at the periphery of the surgical collection (a-c) which may suggest residual pathological tissue. The early follow-up MRI examination shows no areas of abnormal enhancement at the periphery of the lesion (d-f) confirming that the depicted areas of enhancement are due to the presence of inflammatory alterations related to ORC implantation.
Conclusion

Breast reconstruction, after breast conservative surgery, using ORC has been introduced in recent years to optimize oncologic safety and cosmetic outcomes (4,5).

When applied to surgical residual cavity, ORC can lead alterations in surgical breast scar then it could be misinterpreted as tumor recurrence at follow-up radiological examinations.

In Literature there are few works with small number of cases, about the postoperative imaging of ORC. In particular, Oto et all analyzed MRI characteristics of ORC in six patients who underwent abdominal surgery with absorbable mesh implantation and they analyzed the possibility to distinguish between the oxidized regenerated cellulose and the presence of intra-abdominal abscesses (18). Is it possible that during the early postoperative phase, the signal intensities reflect the signal characteristics of the clot that has caused saturation and swelling of ORC fibers. It has been poposed that high deoxyhemoglobin concentration in hypoxic red blood cells in the clot is responsible for the shorter T2 relaxation time, leading to marked hypointensity on T2w images.

Therefore ORC has a short relaxation time on T2w images, resulting in low signal intensity in these sequences, the most sensitive in the detection of this material, and don’t show contrast enhancement on T1w sequences after gadolinium.

In the present study, we have analyzed MRI patterns most frequently observed after conservative breast surgery in a larger sample of Patients; our data revealed that a complex mass, well-encapsulated hyperintense collection with circumscribed margins and internal hypointense nodules, was found in the majority of patients (55%) at MRI examinations.

At MRI imaging the presence of hypointense nodules within complex cystic mass can be explained as typical granulomatous foreign body reaction induced by the presence of ORC. We named this finding "ile-flottante" (9, 12).

A perilesional vascularization of detected collections (rim enhancement) is probably indicative of compression exerted by Tabotamp on neighboring tissues or connected to the presence of granulation tissue around the surgical site.

In 4 cases in which MRI examination revealed focal areas or linear non-mass like enhancement or focal irregular area of enhancement detected at the periphery of the surgical cavity that could simulate a local recurrence, the experience of breast radiologists and subsequent follow-up MRI examinations have allowed to correctly interpret these findings as inflammatory reactions at the periphery of the surgical collections and there was no evidence of tumor recurrence in all of these cases (16-17).
This study has several limitations. First the number of patients was too small. Second, due to the retrospective nature of our study, not all patients underwent MRI examination after the same time from breast surgery. Moreover, a longer period of follow-up might be necessary in order to better understand changes induced in the breast tissue by the use of ORC in the residual surgical cavity, especially in long term follow up.

In addition, in our data analysis, we have not described modifications in MRI pattern, because these features were not considered significant in the assessment of characterization of the lesions observed.

At last, because our Institution is a referral center for breast cancer diagnosis and treatment, all follow-up examinations were evaluated by breast radiologists yet experienced in recognizing breast changes caused by the use of ORC.

In conclusion, when applied to surgical residual cavity, ORC could lead alterations in surgical scar. Thus, MRI examinations during follow-up should be performed by radiologists who well know peculiar properties of this material, who understand the corresponding mammary and scar changes and can correctly interpret them in order to avoid misdiagnosis of tumor recurrence and additional or unnecessary diagnostic examinations or biopsies, both burdensome for patients and the National Health Service.

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References


