Purpose

Architectural distortions at mammography and ultrasound include several lesions with high fibrous content; one of the most frequent is complex sclerosing lesion (radial scar), a benign proliferative lesion with imaging features similar to carcinoma. It has a stellate configuration associated with a central sclerosing stromal proliferation.

The detection of radial scars has become more frequent with the widespread use of screening mammography in asymptomatic women. Its mammographic appearance is an architectural distortion with thin long radiopaque spicules converging toward a central radiolucent core. Unfortunately, the mammographic differential diagnosis between radial scar and breast cancer is difficult.

Moreover, it has been demonstrated that the risk of developing breast cancer is almost twice higher in women with radial scar (1).

Breast contrast-enhanced magnetic resonance imaging (CE-MRI) has been introduced in the clinical diagnostic setting as a problem-solving tool (2) and it could be usefully applied in the detection and characterization of radial scars, although its definitive impact is unclear.

In a recent experience, radial scars were often visualized on CE-MRI as enhancing lesions, but they showed variable morphologic and kinetic features. Similarly to conventional imaging features, CE-MRI characteristics were often suspicious and they could mimic invasive carcinoma of the breast. (3)

In another study, radial scars were detected as non-enhancing findings at CE-MRI and so differentiated from breast cancer; CE-MRI provided 89% specificity, 83% sensitivity and 87% accuracy in depicting radial scars (4).

Moreover, CE-MRI could also be useful in the management of patients with radial scars. As previously reported, patients with high-risk lesions associated with the lowest likelihood of malignancy (such as papilloma and radial scar) and without suspicious MRI findings could safely undergo follow-up instead of breast surgery (5).

Diffusion-weighted imaging (DWI) provides qualitative and quantitative information about tissue cellularity and has been reported to be a useful technique for characterizing enhancing lesions (6, 7, 8). To our knowledge, the additional value of DWI to CE-MRI in characterizing radial scars has not been investigated yet.

The purpose of our study is to evaluate the role of CE-MRI and DWI as a problem-solving tool in the characterization of mammographically and ultrasonographically detected
architectural distortions (suspicious for radial scars) with benign histology at 14G core biopsy.
Methods and Materials

Study population

A retrospective study was conducted on all patients identified in a prospectively collected database as having performed a bilateral breast MRI at our Institute for problem solving from September 2009 to January 2012.

We included only women undergoing bilateral breast MRI to investigate a mammographic or ultrasonographic architectural distortion, confirmed as benign at microhistology.

Reports of the mammographic, MRI, histo-pathological and clinical data of all patients were reviewed. Mammography and CE-MRI findings were compared with histological results.

Breast Magnetic Resonance Imaging

After written informed consent was obtained, each patient performed a bilateral CE-MRI at our Institute on a 1.5 T magnet equipped with magnetic field gradients of 30 mT/m and a dedicated phased-array coil. Examinations were acquired in the prone position, on the 7th to 14th day of menstrual cycle in premenopausal women or for women receiving hormone replacement therapy (HRT) after a 3 months HRT withdrawal.

After localizing scout views, an axial T2-weighted Turbo Spin Echo (TSE) (TR 4,000 ms, TE 120 ms, 436 x 323 matrix, 2.2 mmslice thickness, GAP 0.5, time of acquisition = 2'50") and an axial Echo Planar diffusion-weighted spin-echo sequence (TR/TE 10,000/66 ms, FA 90°, Spectral Presaturation Inversion Recovery fat suppression technique, matrix 224, field of view (FOV) 310x310, slice thickness 3 mm, acquisition time 70 s, b-value 0 and 900 s/mm², time of acquisition = 70") and a contrast-enhanced dynamic three-dimensional T1-weighted gradient echo sequence were performed (TR: 499, TE: 4.6, FOV 375 x 321 x 162, matrix 528, 2.5 mm slice thickness, FA 90°, GAP = 0, time of acquisition = 8'30"). The dynamic study was acquired after intravenous injection of 0.1 mmol/kg of gadolinium chelate at a rate of 2 ml/s, followed by 20 ml of saline and 10 s after the contrast medium injection the T1 weighted fat suppressed sequence was repeated 5 times with the same parameters (Figure 1).

Post processing evaluation

Image analysis was performed using a dedicated software and comprised subtracted images and time-intensity curves of a Region Of Interest (ROI) of at least 3 x 3 pixels placed in the most enhancing region of the lesion. The dynamic curves were classified
as type 1 (progressive enhancement), type 2 (plateau enhancement) and type 3 (wash-out enhancement).

The type of enhancement (focus, mass or non-mass-like) and the morphological features (shape, margin, mass enhancement, distribution modifiers, internal enhancement, symmetry) were evaluated.

The post-processing for DWI included both a qualitative and a quantitative analysis of diffusion properties. We evaluated the difference of signal intensity between the b=900 and b=0 images of the lesion previously depicted on the dynamic study. If possible, a ROI was placed on the lesion in the b=900 image and then transferred to the ADC map to calculate the mean ADC of the lesion, sparing the necrotic and cystic components. In case of lesions larger than 1 cm or inhomogeneous, the ADC value was calculated as the mean of 3 measurements (Figure 2).
**Fig. 1:** Breast MRI protocol

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Fig. 2: Breast MRI post-processing

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Results

From September 2009 to January 2012, 17 patients underwent bilateral breast MRI to investigate a mammographic or ultrasonographic architectural distortion, confirmed as benign at microhistology (fibrosis and adenosis). All patients were female and the mean age was 47 years (age range: 30 - 74 years).

MRI confirmed all known findings and depicted a new architectural distortion. The average size was 19 mm (size range: 7 - 40 mm). In T2-TSE sequence the lesions generally appeared hypointense compared to glandular tissue. Seven distortions were associated to cystic components.

All radial scars showed contrast enhancement, but one. The enhancement pattern was mass-like (n=11) and non mass-like (n=6). The most represented time-enhancement curves were type 1 (n=9) and 2 (n=8); no lesions exhibited a wash-out kinetic.

All radial scars were detectable by DWI. Their mean signal intensity (SI) at b=0 and b=900 were respectively 1.22 (SI range 0.50 - 3.09) and 0.40 (SI range: 0.13 - 0.98), with a 66% decrease of SI (SI decrease range: 52% - 87%). The mean SI decrease of breast parenchyma was 92% (SI decrease range: 74% - 96%).

Quantitative DWI assessed a mean Apparent Diffusion Coefficient (ADC) value of $1.31 \times 10^{-3} \text{mm}^2/\text{s}$, not significantly different than the $1.29 \text{mm}^2/\text{s}$ cut-off between malignant and benign lesions that we previously established in a larger series of patients (9). The mean ADC of breast parenchyma was $1.58 \times 10^{-3} \text{mm}^2/\text{s}$. See figure 3, 4, 5, 6 and 7 for clinical cases.
Fig. 3: Clinical case 1

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Breast MRI showed an asymmetric focal area of enhancement at the same location. On DWI the lesion appeared as hyper-intense, but the ADC value obtained the quantitative analysis on ADC map was borderline (1,29 x10-3 mm²/s)

**Fig. 4:** Clinical case 1

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Woman with family history of breast cancer.

CE-MRI showed an irregular mass enhancement of 3 cm containing small cysts in the lateral upper quadrant of the left breast. On T2 weighted images an hypointense area was seen in the corresponding site. On DWI an hyper-intense lesion appeared, suggesting restricted diffusivity, as confirmed by the quantitative analysis on ADC map (1,16 x10^{-3} \text{mm}^2/\text{s}) .

**Fig. 5:** Clinical case 2

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A breast MRI was arranged to further evaluate a spiculated shadow detected on a surveillance mammogram from another institution. A parenchymal distorsion with no enhancement was seen between the lateral quadrants of the breast. DWI showed an hyper intense area with benign ADC value (1,08 x10-3 mm2/s).

**Fig. 6: Clinical case 3**

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Ultrasound showed a spiculated mass with significant shadowing in the lateral quadrants of the right breast of a 52 year old women with no previous nor familiar history of breast cancer. Breast MRI successfully detected the suspicious lesion and revealed an additional area of enhancement between the inner quadrants of the same breast. Both had ADC value lower than the surrounding glandular tissue (0.9 x10^-3 mm^2/s).

**Fig. 7:** Clinical case 4

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Conclusion

MRI better depicts the extension of architectural distortions and could help in the biopsy planning, which remains mandatory.

Due to frequent enhancement of scars, the high negative predictive value of breast MRI is not a reliable tool for excluding malignancy in this setting. Furthermore, the contribution of qualitative DWI in the differential diagnosis of distortions is limited; this is related to their signal hyperintensity (reflecting a restricted water motion) which is not exclusive of cancer but also occurs in fibrotic tissues.

For these reasons, ADC maps revealed borderline values.

Due to the small size of the population, our results need to be studied in a larger series of patients, with histopathological correlation to the surgical specimen.
References


Personal Information

Dr. Elena Venturini
Dr. Giulia Cristel
Dr. Claudio Losio
Dr. Elena Schiani
Dr. Marta Maria Panzeri
Dr. Simona Tacchini
Dr. Mariagrazia Rodighiero
Prof. Francesco De Cobelli
Prof. Alessandro Del Maschio

Radiology Department
San Raffaele Scientific Institute
Milan, Italy