Spectrum of MRI presentations of radial scars of the breast:
A pictorial review

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Learning objectives

1. To illustrate the MRI patterns of presentations of radial scars based on our case series.
2. To show pathologic, mammographic and sonographic correlation for each pattern of MRI presentation.

Background

Definition:

Radial scar (RS) of the breast (also described as radial sclerosing lesion, sclerosing papillary proliferation, indurative mastopathy, and, if larger than 1 cm, complex sclerosing lesion) is a benign lesion characterized microscopically by epithelial proliferations radiating from a central fibroelastotic core with entrapped and distorted ducts and lobules (1). This irregular, spiculated pattern gives the lesion its characteristic stellate appearance (Fig.1 on page 4).

RS are frequently identified as incidental pathologic findings, with reported prevalences in random autopsy specimens ranging from 14% to 28% (2,3). Occasionally, they are evident at mammography, with detection rates of 0.2-0.6 per 1000 mammographic examinations (4).

The clinical significance of RS is threefold: first, at histopathologic examination, RS can be mistaken for carcinoma (in particular of tubular histotype); second, discrete foci of carcinoma may be found within or adjacent to some RS; third, RS may be an independent risk factor for breast cancer (5).

RS diagnosed at percutaneous biopsy:

It is commonly assumed that a percutaneous biopsy of RS is not reliable in ruling out malignancy, due to potential sampling error (i.e. sampling only the region of RS in a lesion containing both RS and carcinoma) and/or difficulties in histopathologic differentiation from carcinoma in limited biopsy specimens (5)(Fig.2 on page 5). Studies addressing the issue of invasive and/or intraductal carcinoma occurring at surgery after a percutaneous diagnosis of RS have reported very variable underestimation rates, ranging from 0% to 40% (Fig.3 on page 5).
As a consequence, excisional rather than percutaneous biopsy has been generally recommended when imaging findings are consistent with RS (6-11), but controversy exists regarding the need for surgical excision after a percutaneous diagnosis of RS (4,12-16). Biopsy and pathologic criteria such as absence of atypical hyperplasia at biopsy samples, retrieval of at least 12 specimens and extensive sampling with vacuum-assisted large core biopsy devices have been identified as factors that when present may spare a patient from undergoing surgical excision (12-15). The potential role of mammographic and sonographic features in the management of RS diagnosed at percutaneous biopsy has been evaluated with contrasting results (1,13-17).

*Mammography:*

RS has different patterns of mammographic presentation (*Fig. 4* on page 6):

1. **Architectural distortion, with or without associated microcalcifications.** The most typical appearance of RS presenting as architectural distortion ("black star") has been described by Tabar and Dean and include the following: a) central radiolucency; b) radiating long, thin spicules; c) varying appearance in different projections; d) radiolucent linear structures parallel to the spicules; e) absence of a palpable lesion or skin changes (18). However, as many groups have demonstrated, none of these findings is specific and similar features may be seen in carcinoma (11,19).

2. **Stellate opacity,** that is a tridimensional mass, having ill-defined borders, featuring spiked linear extensions, or spicules, which lead out towards adjoining tissue and is indistinguishable from a breast cancer (11,19,20).

3. **Microcalcifications,** with round, punctuate, and ill-defined morphology. However, radio-pathologic studies have shown that, in these cases, calcifications are histologically identified in contiguous areas of adenosis, as well as other areas of epithelial hyperplasia (1,19,21-23).

4. **Occult** (24).

*Sonography:*

Sonography was initially considered to have no role in the imaging RS. However, it has been demonstrated that RS are visible on sonograms, and when they are seen, they are more conspicuous on sonography than on mammography (17,25). In addition, sonography can be helpful in women in whom mammographic findings are subtle or apparent on only one mammographic view to aid the localization of the lesion before percutaneous biopsy (25). The role of sonography in differentiation between RS and breast cancer is still uncertain (17,25,26).

RS has different patterns of sonographic presentation (*Fig. 5* on page 7):
1. Irregularly-shaped hypoechoic mass with ill-defined borders and posterior acoustic shadowing, virtually identical to a carcinoma of the breast (24,25).
2. Focal area of intense shadowing without a discernable mass (24).
3. Solid round mass with smooth margins and without posterior acoustic enhancement or shadowing (24).
4. Occult (25).

A hypothesis to explain the variable sonographic detectability and presentation of RS is represented in Fig.6 on page 8.

Images for this section:
**Fig. 1:** Photograph of a surgical specimen shows a typical radial scar (Hematoxylin-eosin stain [H&E]; original magnification, x1). A central nidus of dense fibroelastotic tissue with radiating fibrous bands (grey circle) is surrounded by a "corona" of glandular proliferation and cysts (white "corolla").

**Fig. 2:** Causes of underestimation of malignancy in case of radial scar diagnosed at percutaneous biopsy.

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**Causes of underestimation of malignancy in case of RS diagnosed at percutaneous biopsy**

**SAMPLING ERROR**

- Invasive lobular carcinoma
- Biopsy site

**DIAGNOSTIC ERROR**

- Difficulty in the differentiation of carcinoma and RS, on the limited material provided by CNB samples.

Percutaneous biopsy: RS

Surgical excision: invasive lobular carcinoma at the edge of a benign RS

Radial Scar

Tubular carcinoma

**Fig. 2:** Causes of underestimation of malignancy in case of radial scar diagnosed at core-needle biopsy.
Fig. 3: Variability in the reported malignancy underestimation rates after a percutaneous diagnosis of radial scar.

<table>
<thead>
<tr>
<th>AUTHOR, YEAR</th>
<th>RS at CNB</th>
<th>Cancer at surgery</th>
<th>Underestimation Rate</th>
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<tr>
<td>Dahlstrom JE, 1996</td>
<td>6</td>
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<td>Lee CH, 1997</td>
<td>4</td>
<td>1</td>
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<td>Jackman RJ, 1999</td>
<td>5</td>
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<tr>
<td>Philpotts LE, 2000</td>
<td>9</td>
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<td>Brenner RJ, 2002</td>
<td>157</td>
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</tr>
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<td>Cawson JN, 2002</td>
<td>62</td>
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<td>6%</td>
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<td>Apesteguia L, 2002</td>
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<td>Becker L, 2006</td>
<td>161</td>
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<td>Lopez-Medina A, 2006</td>
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<td>5</td>
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</tbody>
</table>
**Mammographic appearances of RS**

1. Architectural distortion, with or without associated calcifications

2. Stellate opacity

3. Microcalcifications

4. Occult

**Fig. 4:** Patterns of mammographic presentation of radial scar.
Fig. 5: Patterns of sonographic presentation of radial scar.
One hypothesis to explain the variable sonographic detectability and appearance of RS is the propensity of the lesion to grow in a uniplanar platelike fashion that, if interrogated in a plane parallel with the plane of the lesion, might produce little tissue area to deflect sound, similar to imaging a coin on edge.

*Cohen MA and Sferlazza SJ, AJR 2000*

**Fig. 6:** Explanation of the variable appearance of radial scars on sonographic evaluation.
RS can show several MRI patterns, according to the literature and to our experience.

In particular, over a 4-year period, 25 surgically confirmed RS without atypia were evaluated on contrast-enhanced MRI performed with a 1.5T system in our Department of Radiology.

Four patterns of presentations have been identified (Fig.1 on page 11):

1. **Stellate "architectural distortion", without mass effect, just as in mammography (27,28).** These lesions usually show mild or no enhancement and are better appreciated on non-contrast-enhanced images. In our experience, this pattern accounted for 20% (5/25) of cases. The same lesions were shown on mammography as architectural distortions and, when sonographically visible, as focal areas of acoustic shadowing without a definite mass (Fig.2 and Fig.3 and Fig. 4 and Fig.5).

2. **Irregular or spiculated "tumor-like" mass.** Unfortunately, in these cases, not only morphology but enhancement kinetics of RS may mimic those of invasive breast cancers (27,29-31). Five of 25 (20%) of our cases presented this appearance. These lesions were shown as spiculated opacities on mammography and as irregularly-shaped, hypoechoic masses on sonography (Fig.6 and Fig.7 and Fig.8 and Fig.9).

3. **Benign-looking oval or round mass** with rather smooth margins and mild and gradual enhancement. In our experience, this appearance is rare (2/25, corresponding to 8%). On mammography, these lesions correspond to circumscribed opacities, while, on sonography, they correspond to hypoechoic round masses with smooth margins and without posterior acoustic phenomena (Fig.10 and Fig.11).

4. **Occult.** RS are frequently occult on MRI (32); in particular, in about one third (7/25) of our cases, RS could not be identified on non-contrast-enhanced or contrast-enhanced images.

In conclusion, RS can show variable patterns of presentation on MRI and, in most of cases (pattern 1 and 2), a clear-cut distinction of a RS versus invasive cancer is not possible (Fig.12 on page 21). Accordingly, breast MR imaging cannot be used to help distinguish a RS from breast cancer or to help identify cancer in the periphery of a RS (27,30,33).
Fig. 1: Patterns of MRI presentation of radial scar.

MRI appearances of RS

Pattern 1:
“Stellate” architectural distortion

Pattern 2:
Irregular “tumor-like” mass

Pattern 3:
Benign-looking mass

Pattern 4:
Occult
Pattern 1: “stellate” architectural distortion

![Pattern 1: “stellate” architectural distortion](image)

Coronal unenhanced spoiled gradient-echo T1-weighted image

Coronal contrast-enhanced spoiled gradient-echo T1-weighted image; subtraced image obtained 84 s after contrast injection

**Fig. 2:** Example of MRI pattern 1: "architectural distortion". Please, click on the arrowhead on the right edge of the image for mammographic, sonographic and pathologic correlation.
Fig. 3: Same case as Fig. 2. Mammographic image shows an area of architectural distortion with microcalcifications (magnification), corresponding to a focal area of acoustic shadowing on sonography. Photograph of the surgical specimen shows a very dense fibro-elastotic center (C) and entrapped radiating ducts with proliferative changes and apocrine cysts (arrows).
**Fig. 4:** Example of MRI pattern 1: "architectural distortion". Please, click on the arrowhead on the right side of the image for mammographic and pathologic correlation.
Fig. 5: Same case as Fig. 4. Mammographic right cranio-caudal view shows an area of architectural distortion with typical "black star" appearance. Sonography (not shown) was negative. Photograph of the surgical specimen demonstrates a very dense fibro-elastotic center (C) and peripheral sclerotic bands (arrows).
Fig. 6: Example of MRI pattern 2: "tumor-like mass". Please, click on the arrowhead on the right side of the image for mammographic, sonographic and pathologic correlation.
**Pattern 2: mammographic, sonographic and pathologic correlation**

**Fig. 7:** Same case as Fig. 6. Mammographic left cranio-caudal view shows a focal area of increased density. The correlative sonographic images show a heterogeneously hypoechoic, irregular mass, with significant intralesional vascularization at color-Doppler examination. Photograph of the surgical specimen shows abundant proliferative epithelial component, with minimal elastosis.
Pattern 2: “tumor-like” mass

Coronal unenhanced spoiled gradient-echo T1-weighted image

Coronal contrast-enhanced spoiled gradient-echo T1-weighted image; subtraced image obtained 84 s after contrast injection

Fig. 8: Example of MRI pattern 2: "tumor-like" mass. Please, click on the arrowhead on the right side of the image for mammographic, sonographic and pathologic correlation.
**Fig. 9:** Same case as Fig. 8. Mammographic image shows an ill-defined area of increased density. The correlative sonographic image shows a hypoechoic, irregular mass with mild acoustic shadowing (cursors). Photograph of the surgical specimen shows abundant proliferative ducts and lobules, and minimal fibro-elastotic component.
Fig. 10: Two examples of MRI pattern 3: "benign-looking" mass. Please, click on the arrowhead on the right side of the image for mammographic, sonographic and pathologic correlation.
Fig. 11: Case 1 of Fig. 10. Mammographic image shows a lobulated low-opacity mass, corresponding to a well-defined hypoechoic, benign-looking nodule on sonography. Photograph of the surgical specimen shows that the peripheral epithelial component is well demarcated from the surrounding fat tissue (arrows).
RS versus breast cancer on MRI: a challenging differential diagnosis

<table>
<thead>
<tr>
<th>MRI pattern</th>
<th>Radial scar</th>
<th>Breast cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pattern 1</td>
<td></td>
<td>Tubular carcinoma</td>
</tr>
<tr>
<td>Pattern 2</td>
<td></td>
<td>Invasive lobular carcinoma</td>
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</tbody>
</table>

**Fig. 12:** Difficult differential diagnosis between radial scar and breast cancer on MRI.
Conclusion

RS can have several appearances on MRI, as well as on mammographic and sonographic examinations. The spectrum of MRI presentations spans from non-enhancing lesions to "tumor-like" masses, indistinguishable from invasive carcinoma. Appreciation of these diverse appearances might help avoid misdiagnosis when evaluating breast MR examinations.

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References


