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Radial Scar: What the Radiologist Needs to Know at the End of 2021

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Nearly one million breast biopsies are carried out every year in the United States of which 70% are benign.[1] Of the benign lesions, some are viewed as a precursor to breast cancer and/or associated with increased risk of future breast cancer.[2-5] Such lesions are regarded as high-risk or borderline lesions,[6] which represent an increasing number of observations among core needle biopsies, mainly thanks to more efficient imaging techniques and/or larger needle size.[7] About 10% of core needle biopsies show a high-risk lesion with the vast majority of these lesions in women in their 40s.[8] Currently, the high-risk classification consists of radial scar/complex sclerosing lesion, papillary lesions, lobular carcinoma in situ (LCIS), columnar cell lesions (hyperplasia or flat epithelial atypia), and atypical hyperplasia (lobular and ductal).

In 1999, Alleva *et al.* described radial scars (RSs) as not truly scars; instead, they were idiopathic entities unrelated to prior surgery or trauma with proposed possible causes that included localized inflammatory reaction and chronic ischemia with subsequent slow infarction.[9] Cardenosa has described RSs as being rosette-like proliferations that are most often seen in women between 41-60 years.[10] Classically, the term complex sclerosing lesion (CSL) refers to a radial scar greater than 10mm.[10] The prevalence of RS ranges from 0.1-2/1,000 with screening mammography. However, it has been reported to be present in 2-16% of mastectomy specimens.[11] In addition, the range of incidental RS on autopsy varies from 14 to 28%.[12-15] In this article, we will provide a review of RS. In addition, the imaging appearance of RS will be described. Finally, we will focus on current outcomes and provide an update on its management based on the most recent recommendations.

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Pathology

RS presents with a particular morphological configuration in breast pathology. Its appearance was first described by Rosen *et al.* in 1995.[16] An RS is a pathologic process of uncertain origin that has a unique stellate configuration. It consists of a central fibroelastic core with associated epithelium and distorted ducts and lobules with a peripheral radiating appearance, as can be seen in Figure 1. In addition, the fibroelastic core is contracted and acts as a central nidus; thus, explaining an RS's "pulled inward" appearance. A specific pathologic characteristic of an RS is that it has an intact myoepithelial cell layer. This is an important feature to differentiate it from an invasive carcinoma. When necessary, immunohistochemical staining for myoepithelial cells can help to differentiate RS from an invasive mammary carcinoma.[17]

In addition to the above features, proliferation of the epithelial tissue can be seen along the radiating distorted ducts and lobules. This proliferative process can include a variety of other breast pathologies, such as benign proliferative changes or cysts, duct hyperplasia, sclerosing adenosis and carcinoma (*in situ* or invasive). It has been reported that atypia and carcinoma can be associated within or at the periphery of RS.[18-19] Thus, the pathologic complexity of RS contributes to its imaging appearance. If an RS measures more than 10 mm on pathology, it is called a complex sclerosing lesion.[10]

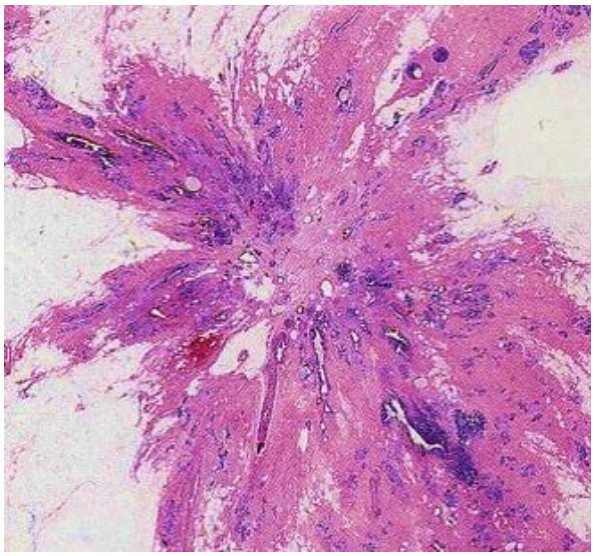

Figure 1. Pathologic specimen of a radial scar demonstrating its fibroelastotic core (arrow) with entrapped ducts and surrounding radiating ducts and lobules, hematoxylin & esoin (x40)

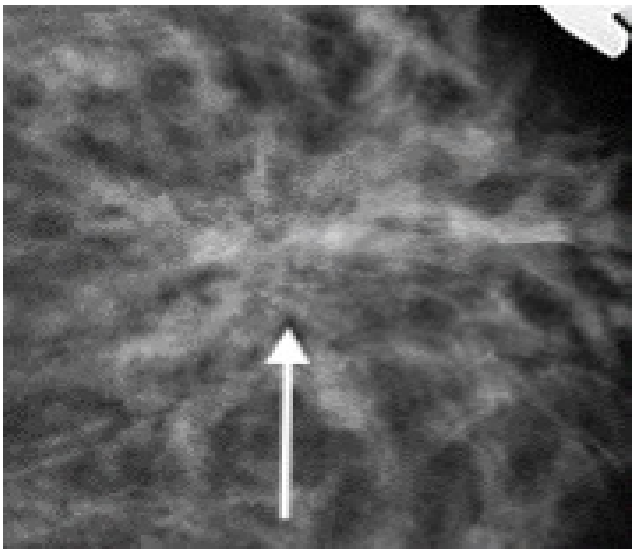

Figure 2. Architectural distortion seen on left CC spot compression mammogram (arrow). Biopsy was performed under stereotactic guidance and yielded RS

Mammogram

In 2001, Tabar *et al*. were the first to establish specific mammographic characteristics of an RS.[20] Their criteria are listed below:

1. Variable appearance in different views
2. No solid dense central nidus
3. A specific spiculated pattern with very long and thin spicules
4. "Black star" appearance, i.e., simultaneous presence of linear tissue structures contrary to the white star appearance seen in cancers
5. No dermal reactions, i.e., no skin thickening or skin retraction
6. Discordance between clinical and radio-graphic appearance, i.e., there is often a discrepancy between the absence of clinical findings and its extensive mammographic appearance

The imaging characteristic of an RS is more commonly known today as architectural distortion (AD), as seen in Figure 2. AD is defined as distortion of the breast parenchymal normal architecture without a definable mass visible.[21] It has been reported that up to 86% of the cases presenting as AD (black star) represent an RS.[11] Other benign lesions that can present as AD include post-procedural scar [surgical excision, prior biopsy, reduction], proliferative fibrocystic changes, and fat necrosis. However, an RS can have the same mammographic characteristics as malignancy.[22] The most frequent malignant lesion to present as AD is invasive ductal carcinoma followed by invasive lobular carcinoma, 65% and 21% of the cases, respectively.[11]

The presence of calcifications is not uncommon with an RS. The calcifications may correspond to one of the benign proliferative changes that coexist with RS. However, the calcifications are nonspecific and cannot help to differentiate a benign from a malignant process on imaging alone. In some rare cases, RS has been reported to present as calcifications only on mammogram.[17]

Compared to conventional mammography (2D), digital breast tomosynthesis (3D) has increased the detection of AD, as illustrated in Figure 3. In the study by Bahl *et al*., AD was more commonly detected in the 3D group than in the 2D group (0.14% [274/202,438 examinations] vs. 0.07% [121/166,661 examinations]; P<0.001).[23] The positive predictive value of malig-nancy for AD was significantly lower in the 3D group than in the 2D (50.7% [139/274 cases] vs 73.6% [89/121 cases]; P<0.001). In addition, RS was the most common non-malignant finding in both groups, but it was more common in the 3D group (33.2% [91/274] vs 11.6% [14/121]; P<0.001).[23]

Ultrasound

The most common ultrasound imaging charac-teristic of an RS is a hypoechoic, irregular mass with indistinct margins,[17] as can be seen in Figure 4. Posterior acoustic shadowing can also be seen with this breast lesion. Sonographically, an RS less often presents as a round or oval mass with circumscribed margins.[24] Also, there may be no ultrasound finding to correspond to the mammographically detected AD. In the study by Cawson *et al*. where 75 RSs and 75 invasive breast carcinomas mammography were detected, only 58 (77%) RSs and 73 (97%) malignancies had an ultrasound correlate.[24]

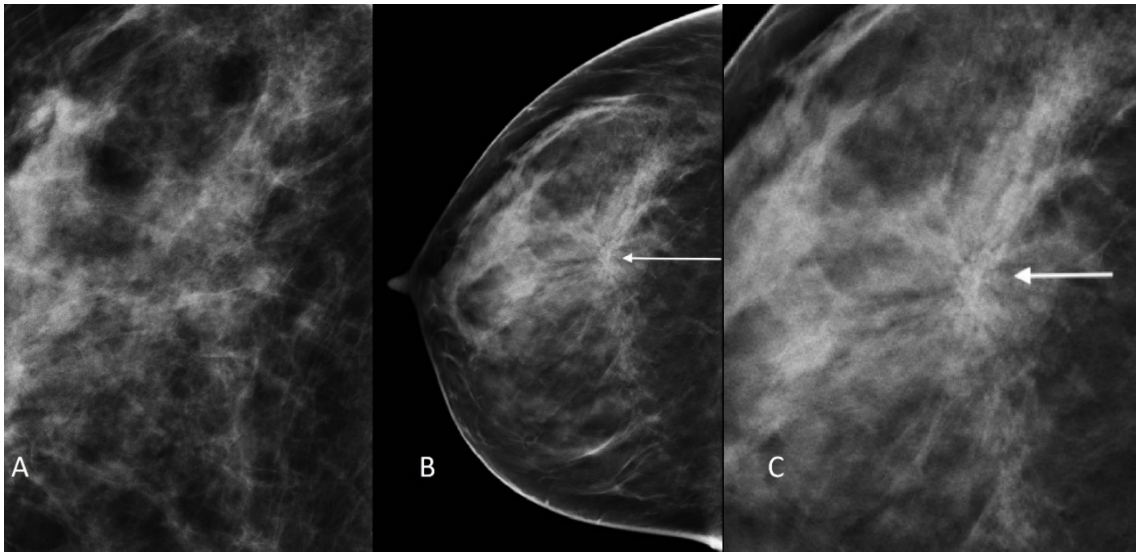

Figure 3. Tomosynthesis-only detected architectural distortion on a screening mammogram in a 55-year old, female patient. 3A) Right CC full-field 2D mammogram enlarged image shows no significant abnormality. 3B) A right CC tomosynthesis image demonstrates architectural distortion (arrow) in central aspect of the breast, posterior depth. 3C) Enlarged image of 3B. The AD had no US correlate. Biopsy was performed under stereotactic guidance and yielded an RS

MRI

On MRI, an RS can appear as non-mass or mass enhancement, as Figure 5 shows. In one study, the authors reported that 63% of their RS cases demonstrated non-mass enhancement with focal distribution, heterogeneous enhancement and a type 3 washout pattern.[25] In the same study, 33% of the RS cases were reported to be an irregular mass. The masses were irregular in shape and margin with heterogeneous enhancement.[25] In another study, the authors reported heterogeneity of the morphologic features and kinetic patterns of RSs and explained these imaging findings by the variability of pathology.[26] The MR characteristics of RS can mimic an invasive malignancy.[30] In addition, not all RSs may enhance. Linda *et al.* demonstrated that of their 31 pathologically proven RSs, only 22 (71%) had a correlate on MRI.[26] In a recent study, Alsharif *et al.* reported that 27 of their 30 (90%) RSs were visible on MRI.[25]

Risk of upgrade

There are multiple publications that have assessed the radiologic and pathologic correlation of RS diagnosed on core needle biopsy with an upgrade to malignancy (invasive carcinoma or DCIS) on surgical specimen. The reported upgrade rates vary from 0 to 45%.[27-33]

In a recent large meta-analysis study consisting of 43 studies that included 3,163 RSs with surgical outcomes, 6.86% (217/3,163) of the RS cases were upgraded malignancy. Of those malignant cases, 2.2% (71/3163) were invasive mammary carcinomas and 4.6% (144/3,163) were DCIS.[33] In addition, the study reported that the likelihood of upgrade was inversely proportional to the size of the biopsy needle.[33] There was a five times higher upgrade for an RS without atypia with a 14-gauge needle core biopsy (NCB) versus vacuum assisted breast biopsy (VAB) with an 8–11-gauge needle core biopsy. In addition, there was a 55% higher upgrade to cancer for an RS with atypia (28% upgrade rate with 14G NCB versus 18% VAB 8-11G biopsies). Lourenco *et al*. also reported an upgrade rate of 23.1% (3/13) for RSs diagnosed on MRI-guided core biopsy.[34]

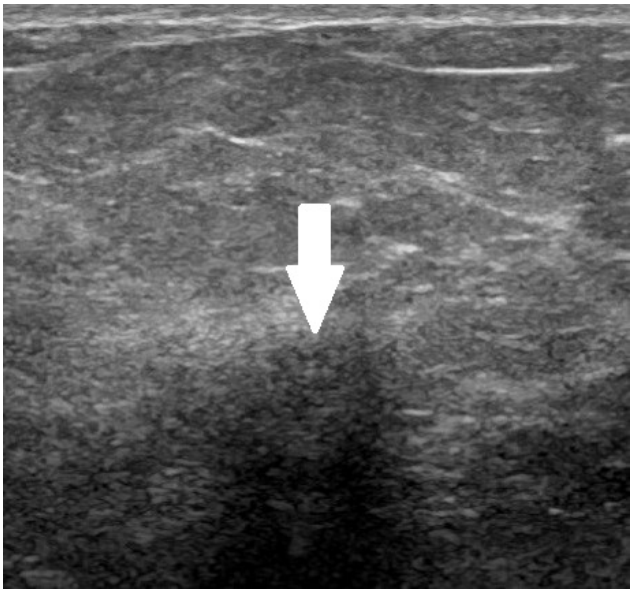

Figure 4. Ultrasound image of a RS demonstrating a 1.5cm, irregular, hypoechoic mass with posterior shadowing (arrow)

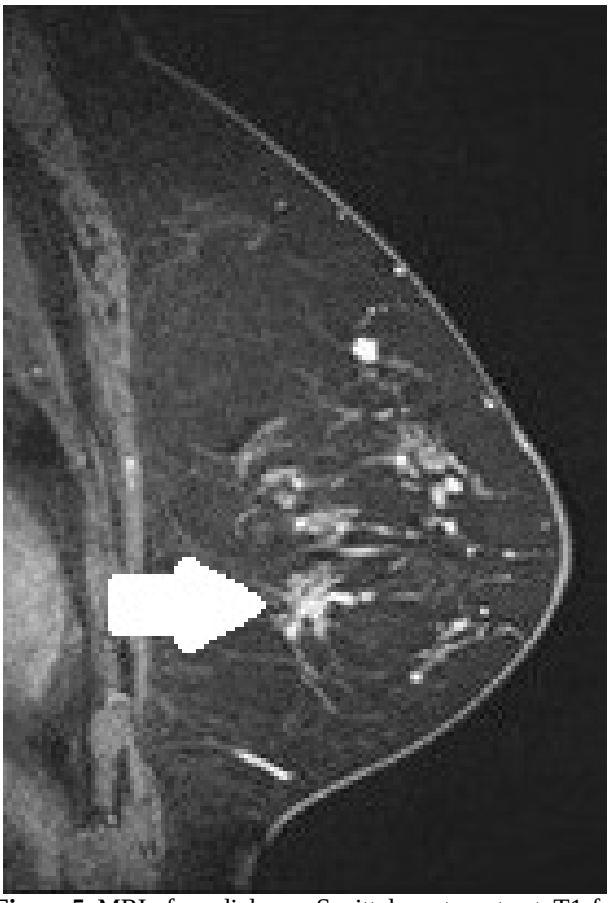

Figure 5. MRI of a radial scar. Sagittal, post-contrast, T1-fat suppressed image shows a 1.5cm, irregular, enhancing mass (arrow) involving the central/inferior aspect of the breast, middle depth.

Breast cancer risk

An RS is often found in association with other high-risk lesions as part of the proliferative breast tissue spectrum. These latter associated lesions may predispose the patient to an increased risk of developing breast carcinoma. However, an RS does not appear to increase the risk of future development of breast carcinoma, except the risk related to an associated high-risk lesion.[17] In a prospective study, Bunting *et al.* analyzed 149 women with a biopsy proved RS without atypia.[35] The mean age of the patients was 52.4 years with a follow up ranging from 9 to 216 months (median 68 months). In their study, five patients developed subsequent carcinoma reaching an incidence of breast carcinoma development of 0.84% per year. This was considered to be equivalent to the relative risk of the average population. They considered patients with a previous history of RS should undergo routine mammography but did not advocate further close follow-up.

An RS diagnosis does not appear to represent an increased risk of breast cancer unlike atypical ductal hyperplasia (ADH), atypical lobular neoplasia (ALH) and classic type lobular carcinoma in situ (LCIS).[17] For example, ALH and LCIS both increase the risk of developing a future breast cancer at a rate of 2% per year for LCIS and 4-5 times the risk for patients diagnosed with ALH.[6] Thus, an RS represents a non-direct precursor in the oncogenesis pathway without increasing the risk of developing breast cancer contrary to other classified high-risk lesions.

Management

The management of an RS diagnosed on image-guided needle core biopsy remains controversial. Until recently, RSs have been surgically excised in large part due to the upgrade rates of malignancy. However, observations could be appropriate in the scenario when an RS without atypia is diagnosed with VAB and in the absence of any additional surgical indication.[36-37] In addition, clinical follow up may be sufficient if an RS is less than one centimeter in size, well sampled and with radiology-pathology concordance.[17]

CONCLUSION

A radial scar is a non-obligate precursor to breast cancer that most commonly presents as architectural distortion on mammography. With the clinical implementation of digital breast tomosynthesis, these lesions are detected more frequently. Although needle core biopsy is still needed for a diagnosis, its management paradigm continues to evolve. Consequently, it is important for the radiologist to understand its pathology, imaging characteristics and radiologic-pathologic correlations.

CONFLICT OF INTEREST

Both authors declare they have no commercial or financial conflicts of interest and any funding sources related to this publication.

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