Primary Angiosarcoma Of the Breast: A Case Report

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ABSTRACT

Primary angiosarcoma of the breast is a rare (0.04% of all malignant breast tumors) and potentially life-threatening disease. Given its variable and non-specific clinical, radiological and pathological presentation, accurate diagnosis is a challenge. Primary angiosarcoma of the breast predominantly occurs in younger patients and it is often overlooked and misdiagnosed at radiology and pathology. To ensure that this aggressive malignancy is not overlooked, radiologists need to be aware of the fact that such tumors may present with non-specific imaging features. We report a case of a 32-year-old female with primary angiosarcoma of the breast presenting with non-specific imaging features. It was initially interpreted as a capillary cavernous hemangioma at histopathology following an ultrasound-guided biopsy. This eventually turned out to be angiosarcoma after a second histopathology opinion was sought in light of the radiology-pathology discordance.

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CASE REPORT

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A 32-year-old nulliparous female patient presented to our breast clinic with gradual increase in size of the right breast over a period of one year. On clinical examination, nodularity of the right breast was observed with minor skin thickening but without any discrete palpable mass, tenderness, skin discoloration and nipple discharge/retraction. The left breast was normal on palpation. A prior breast ultrasonography (USG) performed elsewhere was interpreted as granulomatous mastitis based on the imaging features. The patient had no personal or family history of breast or ovarian cancer. She had undergone a laparoscopic excision of simple ovarian cysts twice in the past.

Given her young age, a USG evaluation of the breast was undertaken at the outset which revealed a diffuse area of altered echotexture containing multiple hypoechoic non-vascular tubular lesions (Figure 1a and 1b) along with subcutaneous and parenchymal edema predominantly in the upper quadrant of the right breast (Figure 2). Neither any discrete mass nor any abnormal axillary lymph nodes were observed. 2D full field digital mammography with 3D tomosynthesis revealed a global asymmetry in the right breast with mild skin thickening without any discrete mass or suspicious calcification. Prominent vessels were observed adjacent to the pectoralis muscle (Figures 3 and 4). Considering the large size of the palpable abnormality and the inconclusive findings on mammography and USG, a dynamic contrast-enhanced magnetic resonance imaging (MRI) was performed. The MRI revealed a large irregular mass showing isointense signal on T1-weighted (T1W) images and hyperintense signal on T2-weighted (T2W) images measuring approximately 10.4 x 10.1 x 7 cm (transverse x anteroposterior x craniocaudal) involving most of the upper quadrant of the right breast (Figure 5). A focal area of restricted diffusion was observed in the superomedial part of the mass (Figure 6). Progressive enhancement with Type 1 kinetic curve was noted

on the dynamic contrast-enhanced sequences (Figure 7). The extent of the lesion was well-appreciated on the sagittal fat-suppressed post-contrast sequence (Figure 8). The MRI findings were considered suspicious and assigned a BI-RADS (Breast Imaging Reporting and Data System, fifth edition) category 4.

Consequently, a core needle biopsy was done with samples taken from multiple sites of the abnormal area in the right breast under USG guidance. The initial histopathological interpretation was capillary cavernous hemangioma. In light of the radiology-pathology discordance, a second histopathology opinion was sought from another pathologist from a different institution who confirmed the presence of a well-differentiated angiosarcoma (Figure 9). Immunohistochemistry (IHC) indicated that the tumor cells were positive for vascular endothelial markers namely CD31 and CD34. Ki-67 index was 20% in the highest proliferative areas. It is a biomarker for assessment of the proliferation index in breast cancer. A high Ki-67 index (>or =15%) indicates aggressiveness of the tumor and correlates with the adverse disease prognosis [1].

The patient underwent right radical mastectomy followed by an immediate breast reconstruction with a deep inferior epigastric perforators (DIEP) flap procedure. The surgical gross specimen exhibited a poorly circumscribed reddish brown soft-to-firm tumor measuring 13.5 x 8 x 5 cm with hemorrhagic areas. The final histopathology indicated an intermediate-grade (II) angiosarcoma in which the tumor was comprised of predominantly low-grade capillary components with anastomosing neoplastic vascular channels that irregularly infiltrated the fat and lobules. The endothelial lining was flat with mildly pleomorphic nuclei. Focally cellular areas were noted with formation of endothelial papillary fronds. Mitotic activity was very low. The tumor infiltrated the nipple areola complex without any ulceration. The subcutis was involved without involvement of the dermis. Neoplastic vascular channels infiltrated the stroma around large lactiferous ducts beneath the nipple. IHC indicated robust expression of endothelial markers (i.e., CD31, CD34 and ERG) in the tumor. Expression of Ki- 67 was up to 40% in the cellular areas.

DISCUSSION

Etiology & Demographics:

Breast angiosarcoma, a malignancy of endovascular origin, is a rare but aggressive tumor [2]. The primary and secondary forms are clinically distinct entities. Primary angiosarcoma of the breast (PAB) usually arises in the parenchyma of non-irradiated breast without any known risk factors. In contrast, secondary angiosarcoma arises in the dermal and subcutaneous layers of the skin of radiated fields after a period of 7-10 years after radiotherapy and may not necessarily involve the parenchyma [3].

Breast angiosarcomas display a strong propensity towards hematogenous rather than lymphogenous metastasis. Metastases have been reported in the lung, skin, liver, bone, central nervous system, spleen, ovary, lymph nodes and heart [4,5].

PABs are rare (0.04% of all malignant breast tumors and only 20% of all breast angiosarcoma cases) and can manifest bilaterally. Primary lesions arise in younger women, usually during the third and fourth decades of life and are often associated with pregnancy [6].

The mean age at diagnosis of secondary angiosarcoma is reported to be about 65 years. It can manifest as either a palpable mass or as mere alteration of the skin color. In contrast to PAB, this disease is apparently associated with risk factors such as radiation therapy after breast conservation surgery and lymphedema (also referred to as the Stewart Treves Syndrome). Such lymphangiosarcoma is typically marked by edema and ulcerative lesions in the breast [2]. It is postulated that chronically obstructed lymphatics may induce the growth of collateral vessels which could induce the transformation to malignant tumors under the influence of vascular growth factors. An alternative theory is that chronic lymphedema may interfere with the repair of genetic mutations in the host, thereby rendering the edematous area as an immunologically privileged site. In addition, it is likely that irradiation may cause genetic insult and/or trigger local inflammation and lymphatic damage that may enhance the potential for lymphedema [7].

Clinical & Imaging Findings:

Patients with PABs typically present with a palpable mass that may be growing rapidly. In up to one-third of the patients, bluish skin discoloration is common possibly due to the vascular nature of the tumor [6].

Mammography findings related to PAB are usually non-specific. The tumor may be frequently missed on mammograms due to the higher density of breasts in young women; this is especially true for low-grade angiosarcoma. Mammograms may appear completely normal in one-third of PAB cases with minor observations of skin thickening. Visible masses may appear round to oval or irregular in shape and may exhibit circumscribed or indistinct margins. Some cases may present as focal asymmetry in conjunction with coarse calcifications [2,8].

The USG features are non-specific. Masses may be circumscribed or ill-defined and hypoechoic or hyperechoic. PAB can also present as diffuse, mixed echotexture regions without a discrete mass, as was observed in our presented case. Color doppler may show hypervascularity [6]. On MRI, the tumor tends to have low intensity on T1W and high intensity on T2W images. Low-grade angiosarcomas show progressive enhancement. High-grade angiosarcomas show rapid enhancement and washout with frequent visualization of large draining vessels. These findings along with multiple unenhanced areas within the tumor may be specific for angiosarcoma [2,3,9].

Results from fine-needle aspiration and punch biopsies are generally not diagnostic and can be misleading due to close resemblance of angiosarcomas to other breast abnormalities.

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Observations from full-thickness incisional biopsies or excisional biopsy specimens should be considered as conclusive [2]. Three grades of PAB have been described namely (a) Low-grade (i.e., comprising of anastomosing vascular channels that invade the surrounding breast tissue) (b) Intermediate-grade (i.e., with solid neoplastic vascular growth and an increased mitotic rate) (c) High-grade (i.e., frankly sarcomatous areas as well as areas of necrosis, hemorrhage and infarction). Since these multiple grades may exist in the same tumor, accurate pathological grading from a core biopsy specimen can be challenging. Therefore, complete tumor excision and diligent histopathological evaluations are necessary for a thorough analysis. Large-sized tumors of PAB can lead to thrombocytopenia and hemorrhagic manifestations (i.e. Kasabach–Merritt syndrome) [6].

IHC for specific biomarkers can be used to differentiate angiosarcoma from invasive carcinomas (ductal/lobular). Absence of cytokeratin and presence of endothelial markers such as CD31, CD34 are confirmatory observations as observed in our case [10,11]. Diffuse staining pattern with factor VIII-related antigen strongly suggests endothelial origins [12]. CD31 is the most specific marker for endothelial differentiation whereas CD34 is more sensitive, but also stains other lesions, such as phyllodes tumor and pseudoangiomatous stromal hyperplasia (PASH) [13]. While benign lesions tend to be well-circumscribed with well-formed vascular channels; sarcomas exhibit invasive features with a high mitotic rate and a high Ki-67. However, misdiagnosis is not uncommon with a high percentage (up to 37%) of cases initially reported as benign [7,9].

Indeed, in our case, preliminary pathological diagnosis after core needle biopsy was a capillary cavernous hemangioma. This was inferred as discordant given the large size of the tumor (>2cm) and the BI-RADS category 4 assigned on imaging. Hence, a second pathology opinion was sought which confirmed the diagnosis of angiosarcoma.

Treatment & Prognosis:

For the surgical management of PAB, mastectomy is preferable to breast-conserving therapy. Positive margins are significantly associated with higher risk of local failure [9]. Node dissection is controversial unless there are clinically positive nodes. Neoadjuvant chemotherapy may assist in changing resectability. Whereas adjuvant therapy may increase survival, some studies suggest no benefit [3]. Hyper-fractionated radiotherapy may be beneficial in locoregional control and may improve the survival [3].

Disease prognosis depends on the tumor grade (the most important factor), the tumor size at diagnosis and the margin status at surgery [14]. The estimated probability of disease-free survival, five years after initial treatment in patients is 76% and 70% in Grade-I and Grade-II tumors, respectively. In comparison, this probability is significantly lower (15%) in patients with Grade-III tumors [6,12]. Positive margins are associated with a worse prognosis [3].

Differential Diagnoses:

The differential diagnoses for low-grade angiosarcomas are hemangioma, angiolipoma, PASH and benign spindle cell proliferative lesions. The differential diagnoses for higher grade angiosarcomas are mastitis, invasive mammary carcinoma, metaplastic carcinoma, squamous cell carcinoma with sarcomatoid features, myoepithelioma, fibromatosis, sarcomas like liposarcoma, fibrosarcoma and malignant phyllodes [4-6,14].

(a) Hemangioma

On mammography, hemangioma may be observed as an oval isodense mass with well-circumscribed margins. Calcifications may be present due to phleboliths. Microlobulations or indistinct margins are less frequent. On USG, this lesion is mostly oval with circumscribed margins. About one-third of these lesions display hyperechoic echotexture and rest of these lesions show isoechoic (to the fat), hypoechoic, or complex echotexture. A superficial location is another characteristic of this lesion. On MRI, hemangioma is often seen as an ovoid mass with circumscribed margins. It appears isointense on T1-weighted images and hyperintense on T2-weighted images, owing to the slow flow of blood in this lesion. Peripheral arterial enhancement may be seen with delayed central enhancement (fill-in) on contrast-enhanced images [8,15].

On pathology, angiosarcomas and hemangiomas are composed of thin-walled capillaries lined by low nuclear grade endothelial cells. Mitotic figures are rare in well-differentiated angiosarcomas and may not be present with limited sampling. However, hemangiomas differ from angiosarcomas in that they are usually less than 2 cm, are well circumscribed and their vascular channels surround the ducts and lobules rather than invading them [16].

(b) Angiolipoma

These fat-filled abnormalities usually display intra-lesional lucent areas on mammography with circumscribed margins and can mimic low-grade angiosarcomas. On USG, these lesions typically appear as homogeneously hyperechoic masses and show fat content on MRI [6,15].

(c) Fibroadenoma

Well-differentiated angiosarcoma can mimic fibroadenoma which commonly presents as circumscribed oval lesion on mammography and oval hypoechoic encapsulated mass with parallel orientation on USG. On MRI, it appears as an oval mass with circumscribed margins showing hypo- to isointense signal on T1W images and hypo- to hyperintense signal on T2W images. On dynamic contrast-enhanced MRI, the Type 1 or Type 2 enhancement curves may be noted with frequent visualization of the non-enhancing septae [12].

(d) PASH

This is a benign lesion formed by myofibroblasts involving the intralobular and interlobular stroma, most commonly affecting premenopausal women. Mammography usually shows a mass or focal asymmetry. The mass appears as a circumscribed, non-calcified lesion that may enlarge over time. On USG, this lesion shows hypoechoic echotexture and

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may demonstrate cystic spaces. Focal or segmental enhancement with Type 2 and Type 3 kinetics can be seen on MRI. Since the imaging features are often non-specific, histological confirmation with core biopsy is necessary. Although PASH may mimic a vascular lesion on microscopic examination, it lacks cytological atypia and mitosis as well as the other diagnostic features of angiosarcoma such as endothelial markers [15,17].

(e) Phyllodes Tumor

These tumors are mainly observed in women between the age groups of 40-60 years. Benign tumors manifest as well circumscribed lesions while malignant tumors are irregular. The most common USG features are of a solid mass containing round or cleft-like cystic spaces and demonstrating posterior acoustic enhancement and internal vascularity. These features can mimic low-grade angiosarcoma. The MRI features include a mixed solid-cystic lobulated mass, T2W hyperintense "slit-like" cystic channels and persistent intense enhancement of the solid components of the mass [15,18].

(f) Mastitis

It can present as a focal or global asymmetry on mammograms with or without skin thickening. On sonography, these lesions can be observed as irregular hypoechoic lesions with or without mobile internal echoes. MRI shows heterogeneous ill-defined masses and non-mass enhancement with mixed kinetics. Restricted diffusion may also be seen. Clinically, the patient presents with pain and signs of inflammation [19].

(g) Invasive Mammary Carcinoma

The high-grade carcinomas with triple negative receptor status occur in younger age group as also seen in the case of PAB. These lesions can mimic benign tumors due to their high cellularity and rapid cell turnover resulting in pushing margins with absence of desmoplastic reaction. The low-grade carcinomas, on the other hand, occur in the older age group and exhibit desmoplastic reaction. Therefore, these tumors show spiculated margins, peri-lesional echogenic halo and posterior acoustic shadowing on imaging. Axillary lymph nodal involvement is commonly observed in mammary carcinomas which is rare in PAB. On MRI, these lesions can appear as irregular masses with Type 2 or 3 enhancement pattern [17].

(h) Metaplastic Carcinomas

These tumors present as round or lobular masses with indistinct margins on mammography and hypervascular solid masses on sonography. MRI shows similar features. However, these tumors frequently involve the axillary lymph nodes and may be associated with ductal carcinoma *in situ* (DCIS) or areas of typical invasive carcinoma [18].

(i) Other Sarcomas

Angiosarcomas of the breast are not as circumscribed as other breast sarcomas and grow as ill-defined hemorrhagic mass lesions with less cellular components widely dispersed around the main portion of the tumor. These observations may explain the findings of architectural distortion seen in angiosarcoma cases compared to other breast sarcomas [18].

TEACHING POINT

Primary angiosarcoma of the breast can be often radiologically and pathologically misdiagnosed owing to its non-specific features on imaging and can be mistaken for benign lesion on histopathology. A high index of suspicion and careful attention to radiology-pathology concordance is essential to ensure that one does not overlook and delay the diagnosis of this aggressive malignancy.

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FIGURES

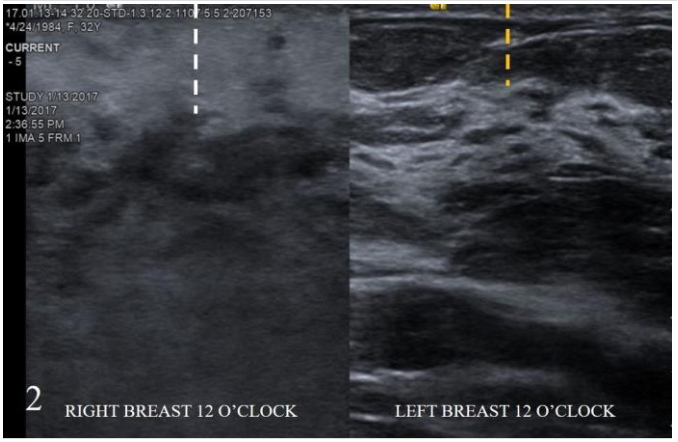

Figure 2: 32-year-old Female Patient with Primary Angiosarcoma of the Right Breast.
FINDINGS: Subcutaneous and parenchymal edema in the right breast (white dashed line) compared with normal subcutaneous fat in the left breast (yellow dashed line).
TECHNIQUE: Grey-scale ultrasound examination performed with 9 MHz linear transducer.

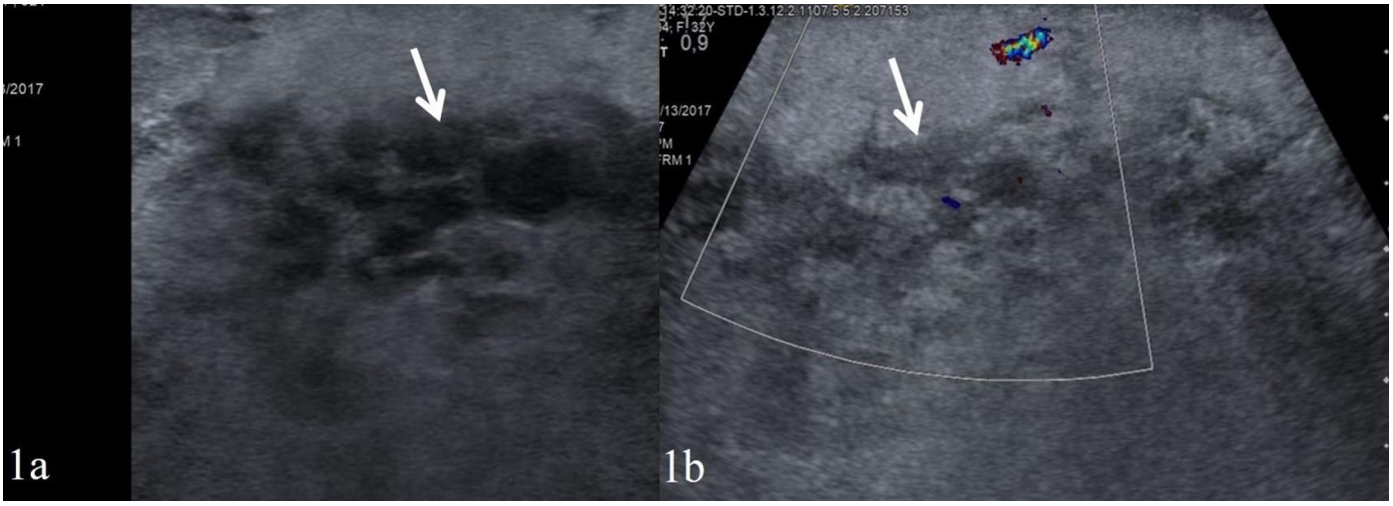

Figure 1: 32-year-old Female Patient with Primary Angiosarcoma of the Right Breast.
FINDINGS: A diffuse area of altered echotexture containing multiple hypoechoic tubular lesions (arrow in Figure 1a). No internal vascularity on color doppler image (arrow in Figure 1b).
TECHNIQUE: (1a) Grey-scale ultrasound examination of the right breast performed with 9 MHz linear transducer. (1b) Color doppler performed with 9 MHz linear transducer.

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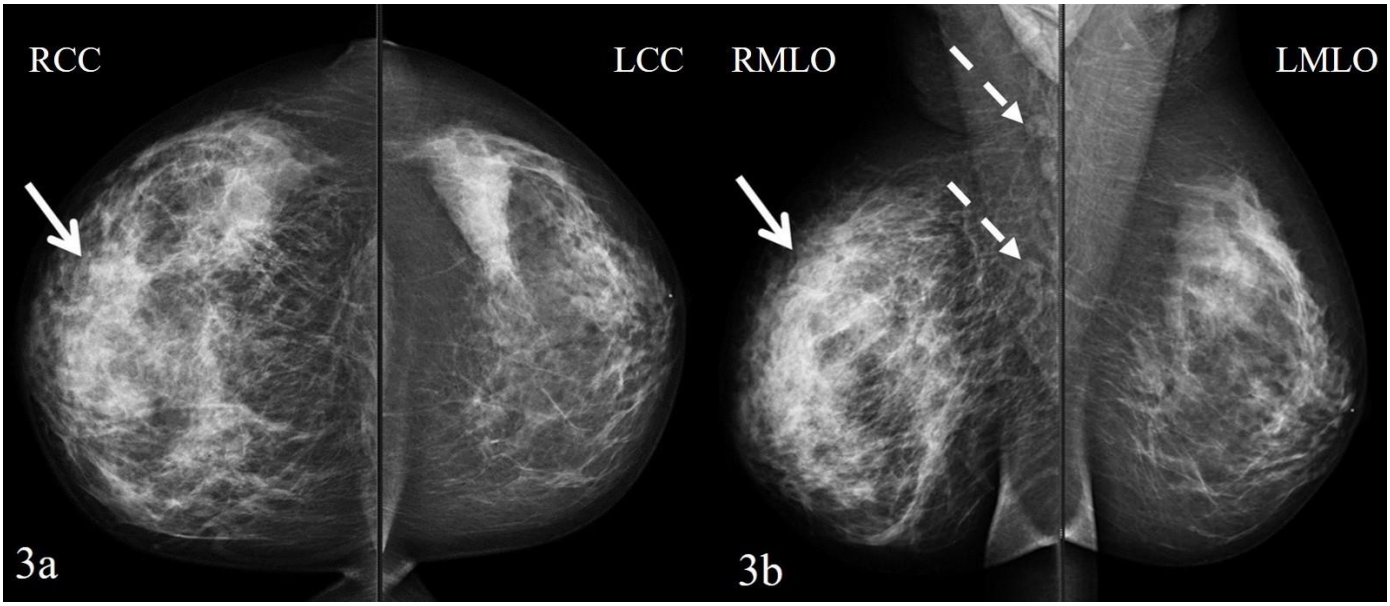

Figure 3: 32-year-old Female Patient with Primary Angiosarcoma of the Right Breast.
FINDINGS: Global asymmetry in the right breast (arrow in Figures 3a and 3b). Prominent vessels adjacent to pectoralis muscle (dashed arrows in Figure 3b).
TECHNIQUE: 2D full field digital mammography performed with KVP 30 and exposure 160 mAs. Anode-tungsten, filter-rhodium. Bilateral cranio-caudal (a) and medio-lateral oblique (b) views.

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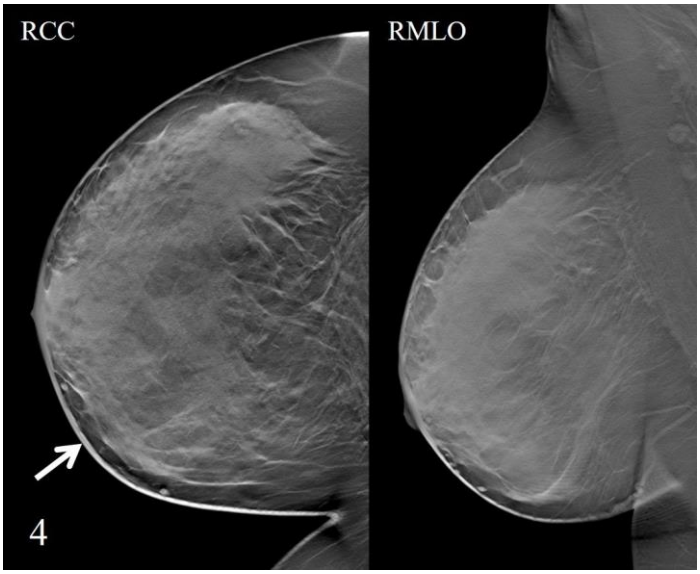

Figure 4 (left): 32-year-old Female Patient with Primary Angiosarcoma of the Right Breast.
FINDINGS: No discrete mass on 3D digital breast tomosynthesis. Mild skin thickening of the right breast (arrow).
TECHNIQUE: 3D full-field digital breast tomosynthesis performed with KVP 30 and exposure 420-480 mAs in cranio-caudal and medio-lateral oblique views. Anode-tungsten, filter-rhodium. Slice thickness 1 mm.

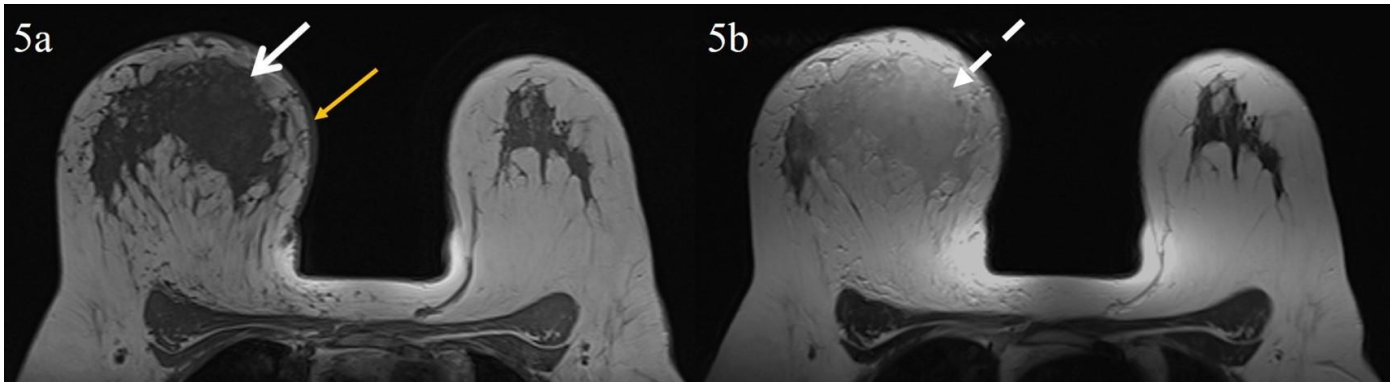

Figure 5: 32-year-old Female Patient with Primary Angiosarcoma of the Right Breast.
FINDINGS: An irregular mass showing isointense signal on T1W images (white arrow in Figure 5a) and hyperintense signal on T2W images (white dashed arrow in Figure 5b) involving most of the upper quadrant of the right breast. Mild cutaneous thickening of the right breast (yellow arrow in Figure 5a).
TECHNIQUE: 1.5 Tesla magnet (a) Axial MRI T1W sequence. Slice thickness 1.4 mm, TR 14, TE 4.7. (b) Axial MRI T2W sequence. Slice thickness 4 mm, TR 3600, TE 66.

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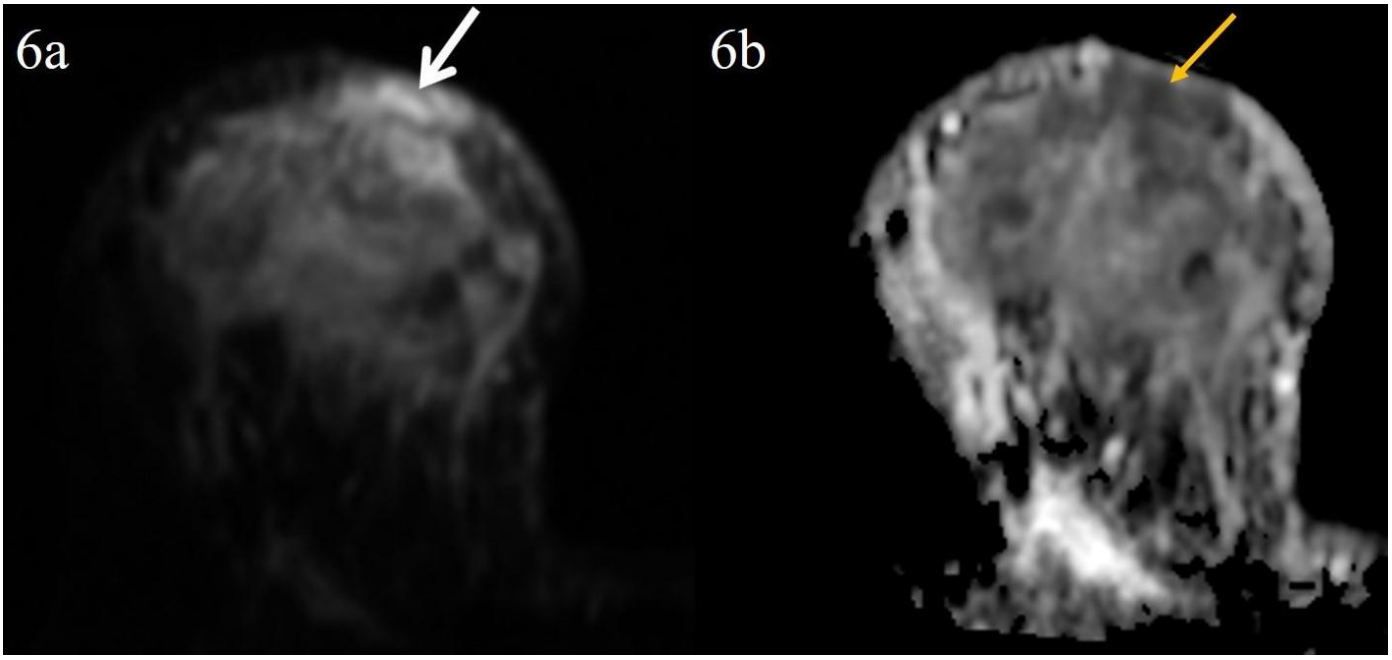

Figure 6: 32-year-old Female Patient with Primary Angiosarcoma of the Right Breast.
FINDINGS: Focal area of restricted diffusion in superomedial part of the mass. High signal intensity on diffusion weighted images (DWI) (white arrow in Figure 6a) and low signal intensity on ADC (Apparent Diffusion Coefficient) parametric map (yellow arrow in Figure 6b).
TECHNIQUE: 1.5 Tesla magnet (a) DWI with b values 0 and 800 sec/mm2. Slice thickness 5 mm, TR 5200, TE 82 (b) ADC map. Slice thickness 5 mm, TR 5200, TE 82.

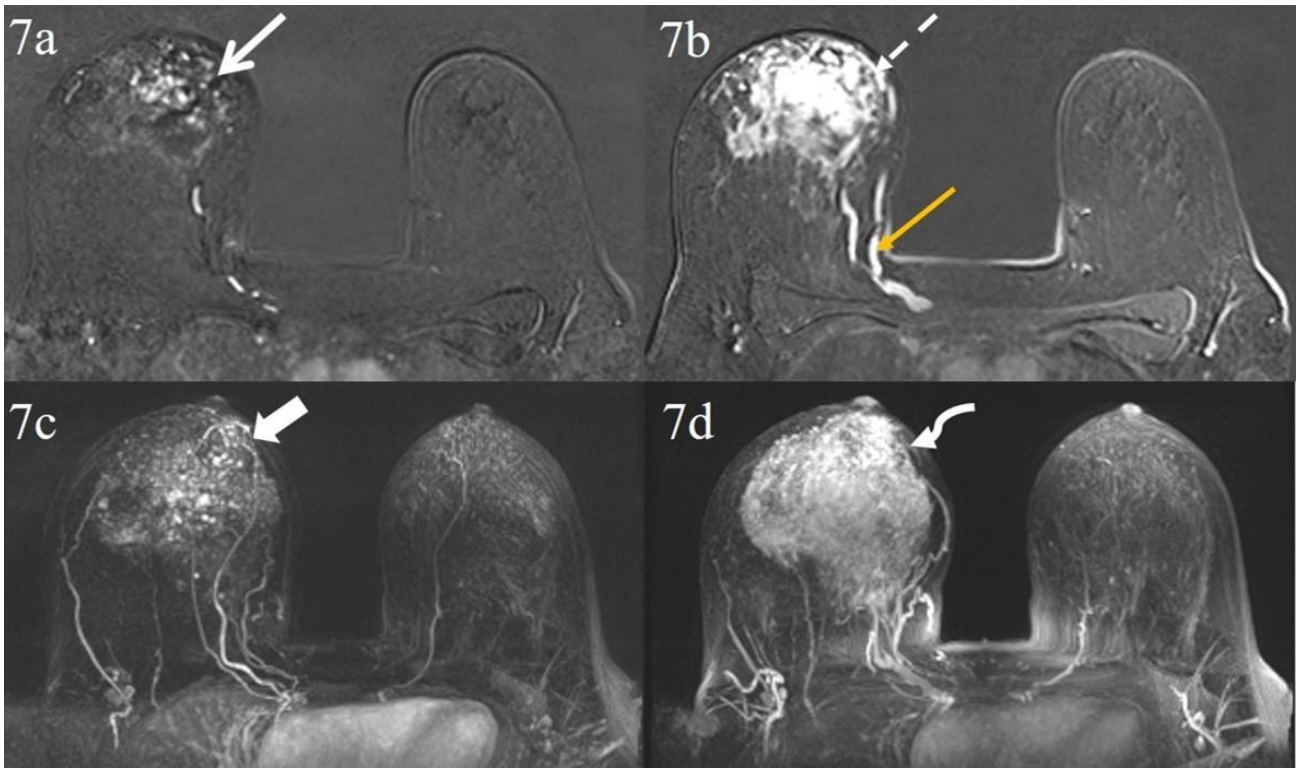

Figure 7: 32-year-old Female Patient with Primary Angiosarcoma of the Right Breast.
FINDINGS: An irregular heterogeneously enhancing mass in upper quadrant of the right breast during early phase (90 seconds) post-contrast fat-suppressed subtracted axial T1W image (white arrow in Figure 7a) and during late phase post-contrast fat-suppressed subtracted T1W image (white dashed arrow in Figure 7b). Same mass seen in MIP (Maximum Intensity Projection) images at the level of nipple during early phase post-contrast fat-suppressed subtracted T1W image (white block arrow in Figure 7c) and during late phase post-contrast fat-suppressed subtracted T1W image (white curved arrow in Figure 7d). Prominent internal mammary vessels observed along the chest wall extending towards inner quadrant of the right breast (yellow arrow in Figure 7b).
TECHNIQUE: 1.5 Tesla magnet. Dynamic post-contrast fat-suppressed subtracted axial T1W images. 0.1 mmol/kg intravenous contrast Gadopentetate dimeglumine injected at the rate of 2ml/second followed by a 20 ml normal saline flush (a) during early phase (90 seconds) in upper quadrant of the right breast, slice thickness 1.1 mm, TR 4.2, TE 1.5 (b) during late phase in upper quadrant of the right breast, slice thickness 1.1 mm, TR 4.2, TE 1.5 (c) MIP image at the level of nipple during early phase (d) MIP image at the level of nipple during late phase.

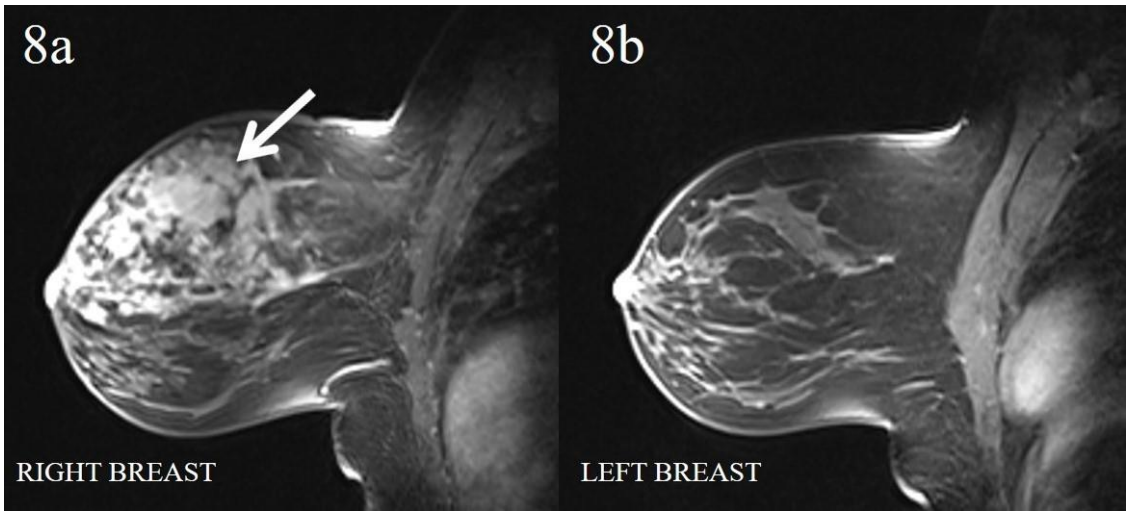

Figure 8: 32-year-old Female Patient with Primary Angiosarcoma of the Right Breast.
FINDINGS: A large irregular enhancing mass involving most of the upper quadrant of the right breast (arrow in Figure 8a). The normal left breast for comparison (Figure 8b).
TECHNIQUE: 1.5 Tesla magnet. Sagittal MRI T1W fat-suppressed post-contrast sequence of the right breast (Figure 8a) and the left breast (Figure 8b). 0.1 mmol/kg intravenous contrast Gadopentetate dimeglumine injected at the rate of 2ml/second followed by a 20 ml normal saline flush. Slice thickness 1.2 mm, TR 4.2, TE 1.5.

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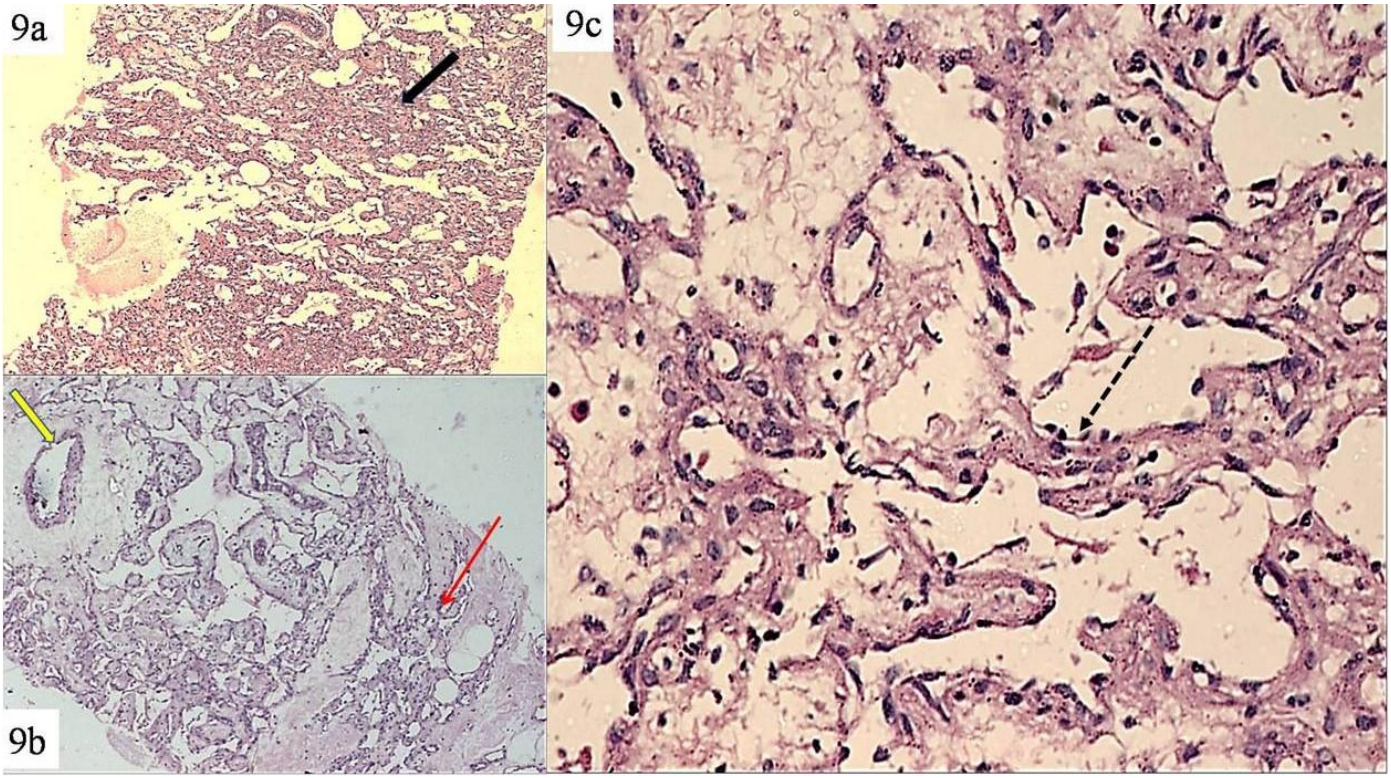

Figure 9: 32-year-old Female Patient with Primary Angiosarcoma of the Right Breast.
FINDINGS: (a) An irregular mass composed of complex anastomosing vascular channels (black block arrow in figure 9a). (b) Infiltration of the tumor into and surrounding the adipose tissue (Red arrow in Figure 9b) while a benign duct also seen (yellow arrow in Figure 9b). (c)Vascular channels lined by atypical and proliferated endothelial cells with minimal cellular and nuclear pleomorphism (black dashed arrow in Figure 9c).
TECHNIQUE: Hematoxylin and eosin stain (a) Low power view (b) Intermediate power view (c) High power view.

Etiology	Idiopathic
Pathology	Malignancy of endovascular origin. Absence of cytokeratin and presence of endothelial markers CD31, CD34 and factor VIII-related antigen.
Incidence	0.04% of all malignant breast tumors and only 20% of all breast angiosarcoma cases.
Gender ratio	Females
Age predilection	Third and fourth decades of life
Risk factors	No known risk factors
Treatment	1. Mastectomy is the treatment of choice. 2. Node dissection is controversial unless clinically positive nodes. 3. Neoadjuvant therapy may assist in changing resectability. 4. Hyperfractionated radiotherapy may be beneficial in locoregional control.
Prognosis	Probability of disease-free survival 5 years after initial treatment is 76% in Grade-I tumors, 70% in Grade-II tumors and 15% in Grade-III tumors. Positive margin has worse prognosis.
Findings on Imaging	1. Mammography- normal (one-third cases), masses with circumscribed or indistinct margins or focal asymmetry. 2. USG- masses may be circumscribed or ill-defined, show hypoechoic or hyperechoic echotexture, can also present as diffuse, mixed echotexture regions without a discrete mass. Color doppler may show hypervascularity. 3. MRI- hypointense on T1W and hyperintense on T2W images. Low-grade angiosarcomas show progressive enhancement while high-grade angiosarcomas show rapid enhancement and washout with frequent visualization of large draining vessels.

Table 1: Summary table of Primary Breast Angiosarcoma.

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	MAMMOGRAPHY	**USG**	**MRI**
PAB	(a) May appear completely normal in one-third of cases. (b) Masses may appear round to oval or irregular in shape and may show circumscribed or indistinct margins. (c) Some cases can present as focal asymmetry (d)Coarse calcifications may be seen.	(a)Non-specific findings. (b)Masses may be circumscribed or ill-defined and may show hypoechoic or hyperechoic echotexture. (c)Tumors can also present as diffuse, mixed echotexture regions without a discrete mass. (d) Color doppler may show hypervascularity.	(a) Low intensity on T1W and high intensity on T2W images. (b)Low-grade angiosarcomas show progressive enhancement. (c)High-grade angiosarcomas show rapid enhancement and washout with frequent visualization of large draining vessels.
Hemangioma	(a)Oval or lobular isodense mass with well-circumscribed margins. (b)Calcifications may be present due to phleboliths. (c)Micro-lobulations or indistinct margins less frequent.	(a)Oval with circumscribed margins. (b)Superficial location. (c)About one-third lesions show hyperechoic echotexture and two-third lesions show isoechoic (to the fat), hypoechoic, or complex echotexture.	(a)An ovoid mass with circumscribed margins isointense on T1W images and hyperintense on T2W images, owing to slow flowing blood. (b)Peripheral arterial enhancement may be seen with delayed central enhancement on contrast-enhanced images.
Angiolipoma	Intra-lesional lucency with circumscribed margins	Homogeneously hyperechoic masses	Oval circumscribed lesions with fat content
Fibroadenoma	Circumscribed oval lesions	Oval hypoechoic encapsulated masses with parallel orientation	Hypo to isointense on T1W images and hypo to hyperintense on T2W images with Type 1 enhancement curve
PASH	Focal asymmetry or circumscribed, noncalcified mass that may enlarge over time.	Hypoechoic lesions with cystic spaces	Focal or segmental enhancement with Type 2 or Type 3 kinetics.
Phyllodes Tumor	Benign tumors manifest as well circumscribed lesions while malignant tumors are irregular.	Solid mass containing round or cleft-like cystic spaces with posterior acoustic enhancement and internal vascularity.	Mixed solid-cystic lobulated mass, T2W hyperintense “slit-like” cystic channels and persistent intense enhancement of the solid components of the mass
Mastitis	Focal or global asymmetry with or without skin thickening	Irregular hypoechoic lesions with or without mobile internal echoes.	Heterogeneous ill-defined masses and non-mass enhancement with mixed kinetics. Restricted diffusion can also be seen.
Invasive Mammary Carcinoma	High-grade tumors mimic benign lesions while low-grade tumors exhibit spiculated margins	High-grade tumors- circumscribed with posterior acoustic enhancement. Low-grade tumors- spiculated margins with posterior acoustic shadowing. Axillary lymph nodal involvement.	Irregular masses or non-mass enhancement. Type 2 or 3 enhancement pattern
Metaplastic carcinomas	Round or lobular masses with indistinct margins	Hypervascular solid masses. May involve the axillary lymph nodes.	May be associated with DCIS or areas of typical invasive carcinoma.

Table 2: Differential diagnoses table for Primary Breast Angiosarcoma.

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ABBREVIATIONS

ADC = apparent diffusion coefficient
BI-RADS = Breast Imaging Reporting and Data System
DCIS = ductal carcinoma in situ
DWI = diffusion-weighted images
IHC = immunohistochemistry
MIP = maximum intensity projection
MRI = magnetic resonance imaging
PAB = primary breast angiosarcoma
PASH = pseudoangiomatous stromal hyperplasia
T1W = T1-weighted
T2W = T2-weighted
TE = echo time
TR = repetition time
USG = ultrasonography

KEYWORDS

Angiosarcoma; Primary; Breast; Mammography; Ultrasonography; Magnetic Resonance Imaging

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