Pictorial Essay

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Imaging Features of the Mesenchymal Tumors of the Breast according to WHO Classification: A Pictorial Essay

WHO 분류에 따른 유방의 중간엽 종양의 영상 소견: 임상화보

Yoon Jung Lee, MD, Yun-Woo Chang, MD*, Eun Ji Lee, MD

Department of Radiology, Soonchunhyang University Seoul Hospital, Seoul, Korea

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***Corresponding author**
Yun-Woo Chang, MD
Department of Radiology,
Soonchunhyang University
Seoul Hospital,
59 Daesagwan-ro, Yongsan-gu,
Seoul 04401, Korea.

Tel 82-2-709-9397
Fax 82-2-709-9066
E-mail ywchang@schmc.ac.kr

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Mesenchymal tumors of the breast, which originate from the mammary stroma, are rare accounting for only approximately 0.5%–1% of all breast tumors. Pathologically, they can exist on a spectrum, ranging from benign to malignant. Such tumors may present with nonspecific findings on breast imaging, including mammography, ultrasound, and MRI, which can lead to diagnostic challenges. In the 2019 revised 5th edition of the World Health Organization classification, breast mesenchymal tumors are categorized into six groups. The current pictorial essay aimed to explore the clinical, pathological, and imaging characteristics of representative lesions in each category according to this six-group classification, with the ultimate goal of enhancing awareness for early diagnosis.

Index terms Breast; Breast Neoplasms; Mesenchymal Tumor; World Health Organization; Imaging

INTRODUCTION

Mesenchymal tumors of the breast arise from the mammary stroma and are rare, accounting for only approximately 0.5%–1% of all breast tumors (1). These tumors encompass a variety of lesions that range in pathology from benign to highly malignant (1). Various types of mesenchymal tumors can develop in the skin or subcutaneous tissues that cover the breast (2). Although the etiology of most cases remains unknown, some have known causes, including viruses such as the Epstein Barr vi-

rus (in immunosuppressed patients) and human herpesvirus 8 (associated with Kaposi sarcoma), as well as angiosarcoma, which is linked to long-standing lymphedema (Stewart Treves syndrome) (3, 4). The imaging findings of each lesion may reflect unique histological features that demonstrate characteristic findings. However, such imaging may exhibit nonspecific features in other cases. Some cases may also present specific challenges in diagnosis that require both clinical physicians and radiologists to be familiar with the particular characteristics of specific lesions, not only in imaging but also in pathology. The prognosis of such tumors depends on the specific disease entity. Complete excision, which plays an important role in predicting local recurrence, is frequently recommended (1). Breast mesenchymal tumors have been classified in a diverse manner in previous studies. The current pictorial essay aimed to explore the clinical and imaging characteristics of lesions categorized according to the 2019 revised 5th edition of the World Health Organization (WHO) classification (5).

WHO CLASSIFICATION OF THE MESENCHYMAL TUMORS OF THE BREAST

The classification of breast tumors has evolved over time. In the fifth edition of the WHO classification of tumor series, which is an update to the fourth edition of 2012, breast tumors are systematically categorized and organized into the following groups: epithelial tumors of the breast, fibroepithelial tumors and hamartomas of the breast, tumors of the nipple, mesenchymal tumors of the breast, hematolymphoid tumors of the breast, tumors of the male breast, metastases to the breast, and genetic tumor syndromes of the breast (1). The 2019 revised WHO classification further divided mesenchymal tumors of the breast into six categories; vascular tumors, fibroblastic and myofibroblastic tumors, peripheral nerve sheath tumors (PNSTs), smooth muscle tumors, adipocytic tumors, other mesenchymal tumors and tumor-like conditions (5). Table 1 presents each category of the classification. The WHO classifies the behavior of tumors in soft tissues and bones into four categories: benign, intermediate (locally aggressive), intermediate (rarely metastasizing), and malignant (5). Most mesenchymal breast tumors are benign (1, 5). Intermediate tumors can be locally aggressive, as in the case of desmoid fibromatosis, which infiltrates nearby tissues, or rarely metastasize to tumors, such as inflammatory myofibroblastic tumors, which have a very low risk of metastasis (1). Malignant breast mesenchymal tumors are characterized by their ability to infiltrate the surrounding tissues and are considered to have a high potential for metastasis. Notable examples of such tumors include angiosarcomas and leiomyosarcomas.

VASCULAR TUMORS

Breast vascular tumors can be categorized as benign or malignant. Benign vascular tumors of the breast include hemangiomas, angiomatoses, and atypical vascular lesions (which can be either lymphatic or vascular lesion). Malignant vascular tumors include post-radiation angiosarcoma and primary angiosarcoma. Based on their site of origin, these tumors can be categorized as either extraparenchymal or intraparenchymal, and the likelihood of malignancy varies between the two categories. Lesions located above the anterior pectoral fascia within the subcutaneous fat are considered to be of extraparenchymal origin (5, 6). Subcuta-

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Table 1. Summary of the Mesenchymal Tumors of the Breast

1. Vascular Tumors	
Benign	Malignant
Hemangioma	Post-radiation angiosarcoma of the breast
Angiomatosis	Primary angiosarcoma of the breast
Atypical vascular lesions	
2. Fibroblastic and Myofibroblastic Tumors	
Benign	Intermediate (locally aggressive or rarely metastazing)
Nodular fasciitis	Desmoid fibromatosis
Myofibroblastoma	Inflammatory myofibroblastic tumor
3. Peripheral Nerve Sheath Tumors	
Benign	Malignant
Schwannoma	Granular cell tumor, malignant
Neurofibroma	
Granular cell tumor, NOS	
4. Smooth Muscle Tumors	
Benign	Malignant
Leiomyoma	Leiomyosarcoma
5. Adipocytic Tumors	
Benign	Malignant
Lipoma	Liposarcoma
Angiolipoma	
6. Other Mesenchymal Tumor and Tumor-Like Conditions	
Pseudoangiomatous stromal hyperplasia	

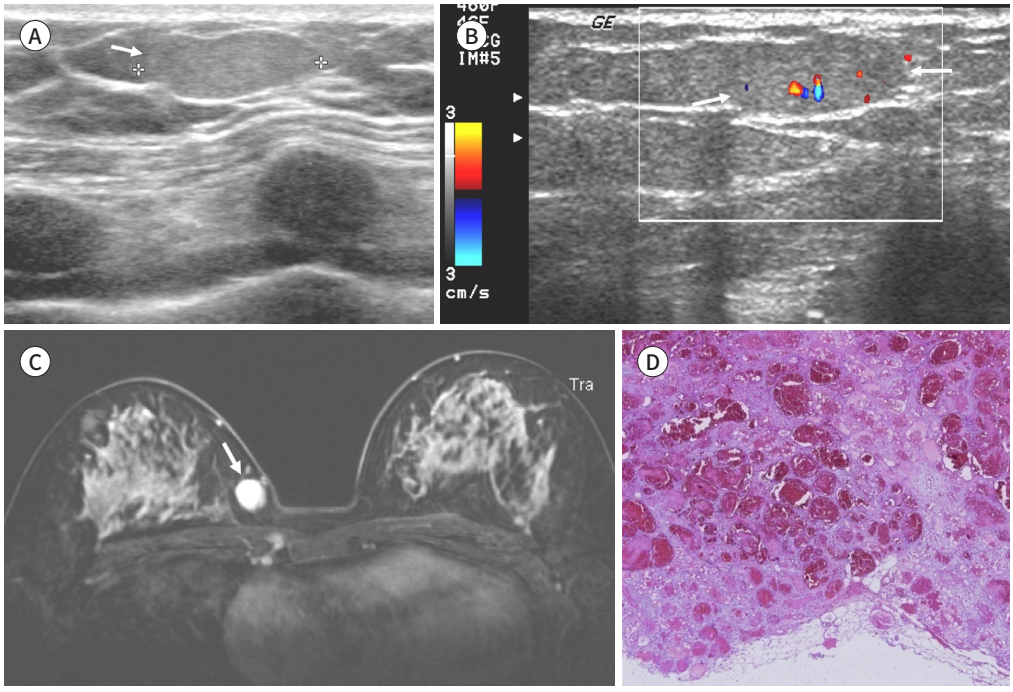
NOS = not otherwise specified

neous vascular masses are typically benign, whereas most lesions within the breast parenchyma are malignant angiosarcomas.

Hemangioma, most common vascular tumor, is characterized by the benign proliferation of mature blood vessels. It can occur in both the mammary parenchyma and subcutaneous tissue but is predominantly found in superficial subdermal or subcutaneous tissues (6). On mammography, it typically presents as a well-circumscribed and lobulated lesion that may contain calcifications (7). On ultrasound, it appears as a lobulated, hypoechoic, well-circumscribed, solid mass, and imay exhibit increased vascularity on Doppler ultrasound due to its blood-vessel-rich nature (Fig. 1). Dynamic gadolinium-enhanced MRI usually shows slow and delayed enhancement, which is indicative of slow blood flow within a lesion (6). It is typically small, often measuring less than 2 cm in size (1). However, as the imaging findings mentioned above are nonspecific, it is necessary to differentiate hemangiomas from other circumscribed masses, such as fibroadenomas or cysts.

Angiomatosis is a benign vascular proliferation that primarily affects a substantial portion of the breast, involving the interlobular stroma, while sparing the intralobular stroma. Occasionally, it extends into the subcutaneous tissue and skin (1). The clinical presentation of angiomatosis may include palpable masses, tenderness, or gradual breast enlargement, sometimes associated with hyperpigmentation or skin papules (8). It presents as multiple irregular anechoic spaces with thin septa and moderate blood flow on Doppler ultrasonography (9).

Fig. 1. Hemangioma (cavernous type) in a 37-year-old woman with no symptoms.
A. US shows a 1.5 cm-sized oval, circumscribed, and isoechoic mass (arrow) in the subcutaneous fat layer of the right upper inner breast.
B. Doppler image shows the increased internal vascularity of the mass (arrows).
C. Axial contrast enhanced T1-weighted MR image shows a round, well-circumscribed, and homogeneously enhancing mass (arrow) corresponding to the lesion detected on US.
D. Microscopically, cavernous, blood-filled vascular spaces separated by connective tissue stroma are noted. The mass was pathologically proven to be cavernous type hemangioma (×200).



On MRI, it typically appears as a multiseptate cystic mass with high signal intensity on T2-weighted images, and the lesion may include tubular structures (10).

Post-radiation angiosarcoma is a rare and aggressive malignancy that develops as a result of previous radiation therapy and often affect the skin or breast tissue. It develops with a median latency period of approximately 6 years following radiation therapy, with reported latency periods ranging from 6 months to 41 years (11). The incidence of post-radiation angiosarcoma has increased in recent years because of the preference for breast-conserving therapy with radiation over radical mastectomy (12, 13). The key difference between post-radiation angiosarcoma and primary angiosarcoma is that the former arises from previously irradiated breast tissue and is more common in older women (median age, 70 vs. 40 years) (14, 15). Clinically, it presents as erythematous patches or nodules in previously irradiated skin areas that progress to red or violaceous plaques and eventually to ulceration (11, 16). After radiation treatment for breast surgery, any signs of skin thickening on mammography or ultrasonography could be an indicators of post-radiation angiosarcoma. Breast MRI is the most helpful modality for the evaluation of post-radiation angiosarcoma, which reveals skin thickening with heterogeneous skin enhancement and, in some cases, intraparenchymal enhancing masses, that often exhibit a rapid enhancement and washout kinetic pattern (Fig. 2) (17). Post-radiation angiosarcoma emphasizes the importance of early and vigilant diagnosis

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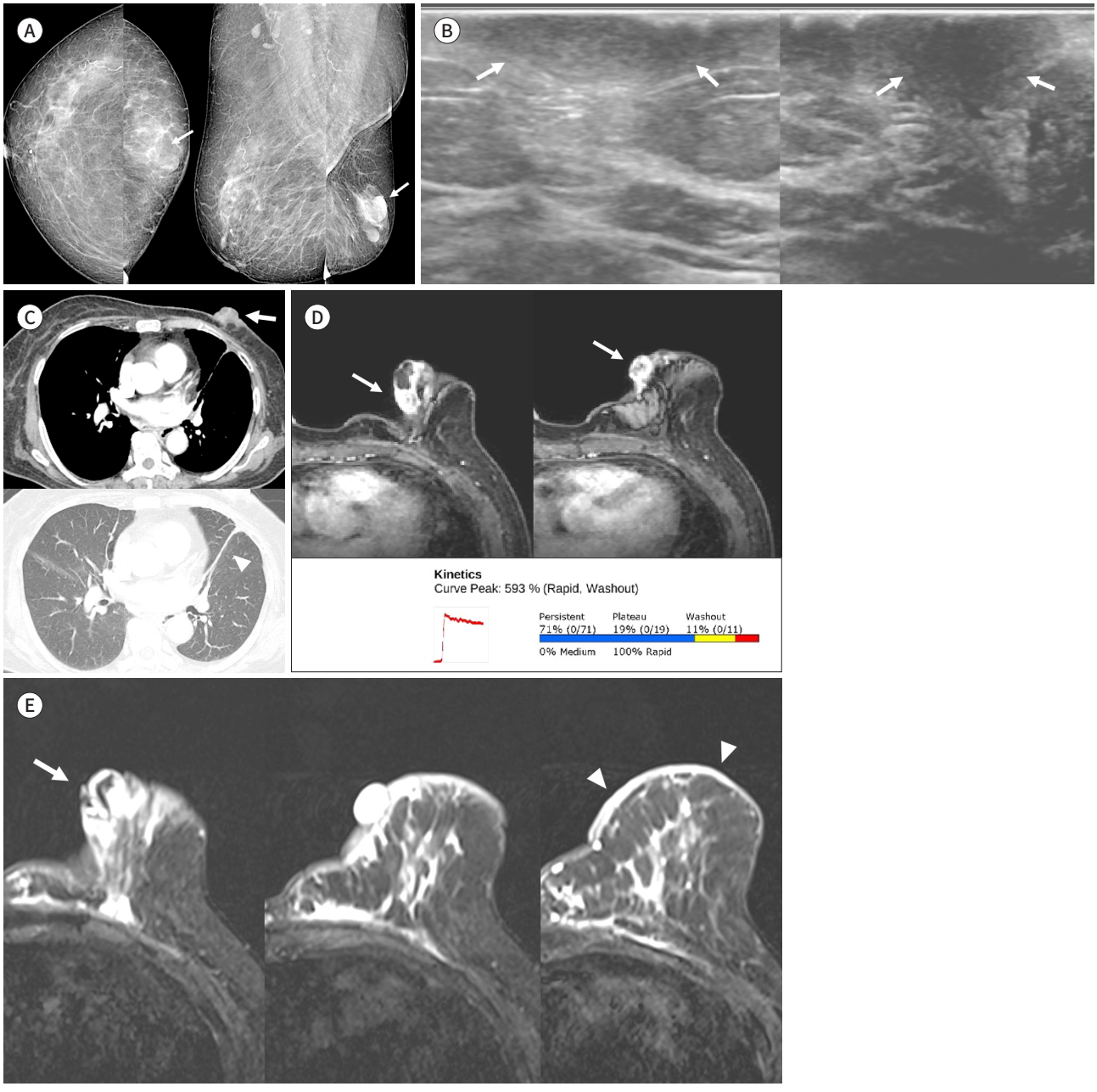
owing to the limited treatment options, poor prognosis, and high risk of recurrence.

Primary angiosarcoma of the breast is a malignant endothelial neoplasm that originates in non-irradiated breast parenchyma. It is more common in young women, typically in their

Fig. 2. Post-radiation angiosarcoma in an 85-year-old woman with a history of left partial mastectomy 10 years prior.
A. Craniocaudal and mediolateral oblique views from mammography show an irregular and high density mass (arrows) in the left upper inner breast with underlying architectural distortion and post-operative change in the left breast.
B. US shows an irregular, indistinct, and hypoechoic lesion (arrows) in the skin, near the left nipple.
C. Contrast enhanced chest CT (mediastinal and lung setting axial images) shows a protruding enhancing mass infiltrating the adjacent skin and left nipple (arrow) and fibrotic linear opacities in anterior aspect of the left lung suggesting radiation-induced subpleural fibrosis (arrowhead).
D. Breast dynamic enhanced T1 weighted images acquired 2 months later show a heterogeneously enhancing protruding mass and skin thickening (arrows), with rapid enhancement and washout pattern on the time intensity curve.
E. T2 weighted fat-suppressed images show a focal high signal intensity mass (arrow) with skin thickening and edema (arrowheads).



40s, and is associated with poor prognosis (14). Patients often present with palpable breast masses or diffuse breast enlargement (18). High-grade tumors exhibit rapid enhancement with washout kinetics and high signal areas on T1-weighted images, indicating the presence of hemorrhage, whereas lower-grade tumors demonstrate plateau or persistent enhancement kinetics (19). Breast primary angiosarcoma, a rare and unique tumor, lacks a standardized treatment approach; however, primary treatment options typically involve surgical intervention along with adjuvant chemotherapy and/or radiotherapy (20).

FIBROBLASTIC AND MYOFIBROBLASTIC TUMORS

Among soft tissue tumors, fibroblastic and myofibroblastic tumors of the breast are rare. Although they can occur at any age, they tend to be more common in young individuals (21). Benign breast tumors include nodular fasciitis and myofibroblastomas. Tumors demonstrating intermediate behavior can be classified into two categories: those that are locally aggressive, such as desmoid fibromatosis, and those that rarely metastasize, such as inflammatory myofibroblastic tumor (1, 5).

Nodular fasciitis is characterized by the benign clonal proliferation of fibroblastic and myofibroblastic cells that typically occurrs in younger patients and often displays spontaneous regression. It can originate in both the subcutaneous tissue and breast parenchyma and has a higher incidence in the upper outer quadrant (1, 5). Although the exact pathogenesis is not well understood, local injury is believed to induce a reactive proliferative process, with approximately 10% of patients having a history of trauma (22). Clinically, it presents as a rapid growing mass that can sometimes be tender or painful and which progresses over weeks and regresses over months (1, 5). Imaging findings are nonspecific, with mammography showing a dense, microlobulated, or irregular mass and ultrasound revealing a hypoechoic solid mass with irregular and angular margins (23). Hence, the significance of this disease lies in its possibility of it being confused with malignancy, despite it being benign. A key differentiator of malignancy is nodular fasciitis, which tends to occur more frequently in the superficial layer and exhibits distinctive clinical manifestation (22).

Myofibroblastoma is a benign mesenchymal tumor that originates from stromal fibroblasts and is most frequently observed within the parenchyma of breast lesions. It exhibits a slight male predominance and is associated with gynecomastia (1, 5). Clinically, it is characterized as a solitary, painless, mobile, and non-tender mass that grows slowly over several months or years. On mammography, it appears as a well-circumscribed round or oval mass without calcifications. On ultrasound, it presents as a well-demarcated tumor with a variable echo pattern, whereas on Doppler ultrasound, peripheral hypervascularization may be observed. On MRI, it appears as low-to-iso-signal intensity on T1-weighted images and typically as high signal intensity on T2-weighted images (Fig. 3) (24). The differential diagnoses of breast masses in men include gynecomastia, invasive ductal carcinoma, and mesenchymal tumors such as myofibroblastoma or granular cell tumors. In particular, the possibility of myofibroblastoma should always be considered as a part of the differential diagnosis when dealing with a breast mass exhibiting well-circumscribed margins.

Desmoid fibromatosis is a locally aggressive tumor that originates from fibroblasts and myofibroblasts deep within the breast parenchyma. It does not metastasize but has a high

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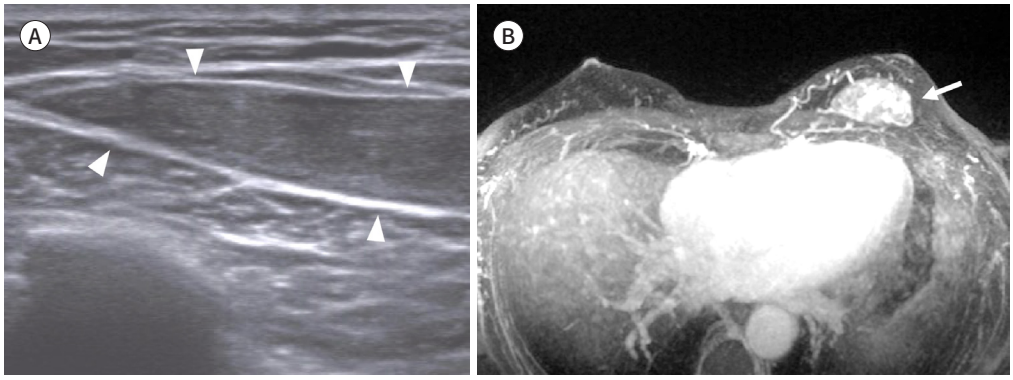
Fig. 3. Myofibroblastoma in a 63-year-old man with palpable mass on the left anterior chest wall.
A. Sonography shows a large, oval shaped, well-circumscribed hypoechoic mass in the subclavicular area of the left breast (arrowheads).
B. Breast MRI maximum intensity projection image shows an oval, circumscribed, and heterogeneously enhancing mass (arrow) in the left breast. Excisional biopsy revealed myofibroblastoma.



rate of recurrence. It has been previously reported to be associated with trauma and familial multicentric fibromatosis (25). The imaging findings are non-specific and can mimic those of breast cancer. It often presents with irregular, finger-like margins as well as infiltration into adjacent tissues, and is frequently associated with skin changes and nipple retraction. In some cases, it may involve chest wall muscles. Therefore, the standard treatment approach is wide surgical resection with safe margins (26).

Inflammatory myofibroblastic tumors are characterized by myofibroblastic and spindle cell proliferation within the backdrop of inflammatory changes. These tumors have intermediate malignant potential, occasional metastatic tendencies, and are prone to local recurrence (1, 27). They most commonly occur in sites such as the lungs, liver, mesentery, and omentum, whereas they rarely occur in the breast. They tend to affect young-to middle-aged women on average in their 40s, and present as painless and slow-growing masses. On mammography and ultrasound, these may appear as an irregular soft-tissue masses with unclear boundaries, and calcifications may be present. MRI typically shows an irregular and uneven soft tissue mass with unclear boundaries and noticeable enhancement (27). Similar to desmoid fibromatosis, it is often crucial to obtain pathological confirmation to distinguish inflammatory myofibroblastic tumors from other breast malignancies because of the challenging imaging findings.

PERIPHERAL NERVE SHEATH TUMORS

PNSTs are diverse neoplasms originating from Schwann cells and associated with peripheral nerve axons, dendritic cells, and fibroblasts. These tumors can manifest in various locations within the breast, including the dermis, deep parenchyma, or axillary soft tissues. They are classified by the WHO into three main categories: Schwannomas, neurofibromas, and granular cell tumors (1, 5).

Schwannomas arising in the breast are exceedingly rare, comprising less than 2%–3% of all schwannomas (28, 29). They commonly affect young adults and can arise within the breast dermis, subcutaneous tissue, breast parenchyma, or axillary soft tissues (1, 28). They may arise spontaneously or be associated with familial tumor syndromes, including neurofibromatosis

type 2, schwannomatosis, and Carney's complex. Breast schwannomas often present as palpable, mobile, and non-tender masses. Imaging modalities, including ultrasonography and mammography, often reveal solid, well-circumscribed, oval or round masses without calcifications. Chest CT or MRI is useful for assessing their size, and similar to schwannomas arising in other locations, they appear as heterogeneously enhanced and well-demarcated masses (Fig. 4) (28). Given that imaging findings often appear benign, breast schwannomas are usually classified as Breast Imaging Reporting and Data System (BI-RADS) 4A lesions (29).

Neurofibromas are benign entities that can occur sporadically or in association with neurofibromatosis type 1 (NF1). They typically manifest in the third or fourth decade of life without sex predilection. They are most commonly found in the superficial dermis and rarely in the deep breast parenchyma. There are three types of breast neurofibromas: diffuse, atypical, and plexiform (1, 5). Patients with NF1 often present with multiple cutaneous neurofibromas. These tumors are typically palpable and mobile, and occasionally present as pedunculated cutaneous lesions that show a preference for the nipple-areolar complex. On mammography, they appear as well-circumscribed oval or round masses. On ultrasound, they may present as hypoechoic masses with posterior enhancement that can sometimes mimic cysts. On MRI, they are typically iso- or hypointense compared to muscles on T1-weighted images and demonstrate heterogeneous high signal intensity on T2-weighted images, often encircled by a peripheral hyperintense ring (Fig. 5) (30). It should be noted that patients with NF1 have an increased risk of developing malignant PNSTs and other cancers, with a two-fold increased risk of breast cancer, particularly in those aged 20–40 years. Malignant PNSTs can develop within pre-existing plexiform neurofibromas, especially if they exhibit rapid growth or cause symptoms. Therefore, when suspicious findings are observed in patients with NF1, it is crucial to consider the potential for malignancy and perform diagnostic procedures that provide pathological confirmation.

Granular cell tumors originate from Schwann cells of the peripheral nerves, and approximately 8% of all granular cell tumors arise in the breast. Such tumors have been reported to be associated with nerve injuries related to previous trauma, and may occasionally coincide

Fig. 4. Schwannoma in a 59-year-old woman with palpable mass in the right axilla.
A. Color Doppler US shows a 3.9 cm-sized oval, circumscribed, and complex echoic mass with peripheral vascularity in the right axilla (level I).
B. Contrast enhanced chest CT shows a heterogeneously enhancing well circumscribed mass in the right axilla (arrow), which correlates with a lesion detected on US. Core needle biopsy was performed, and spindle cell tumor was pathologically confirmed, which is highly suggestive of schwannoma.

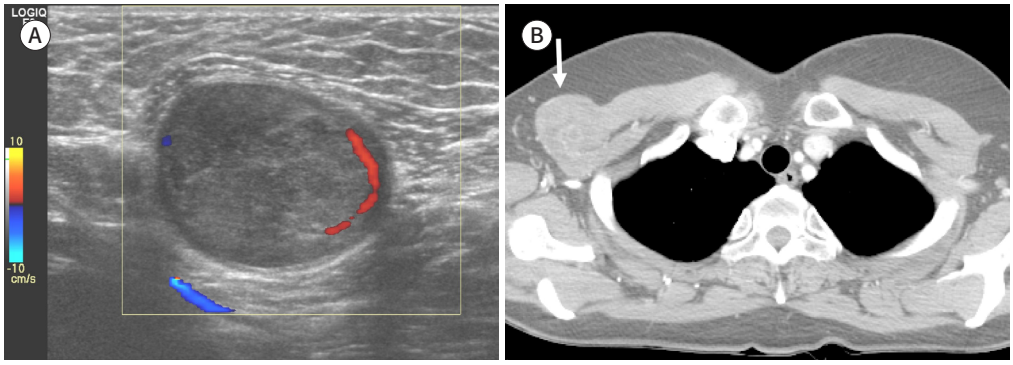


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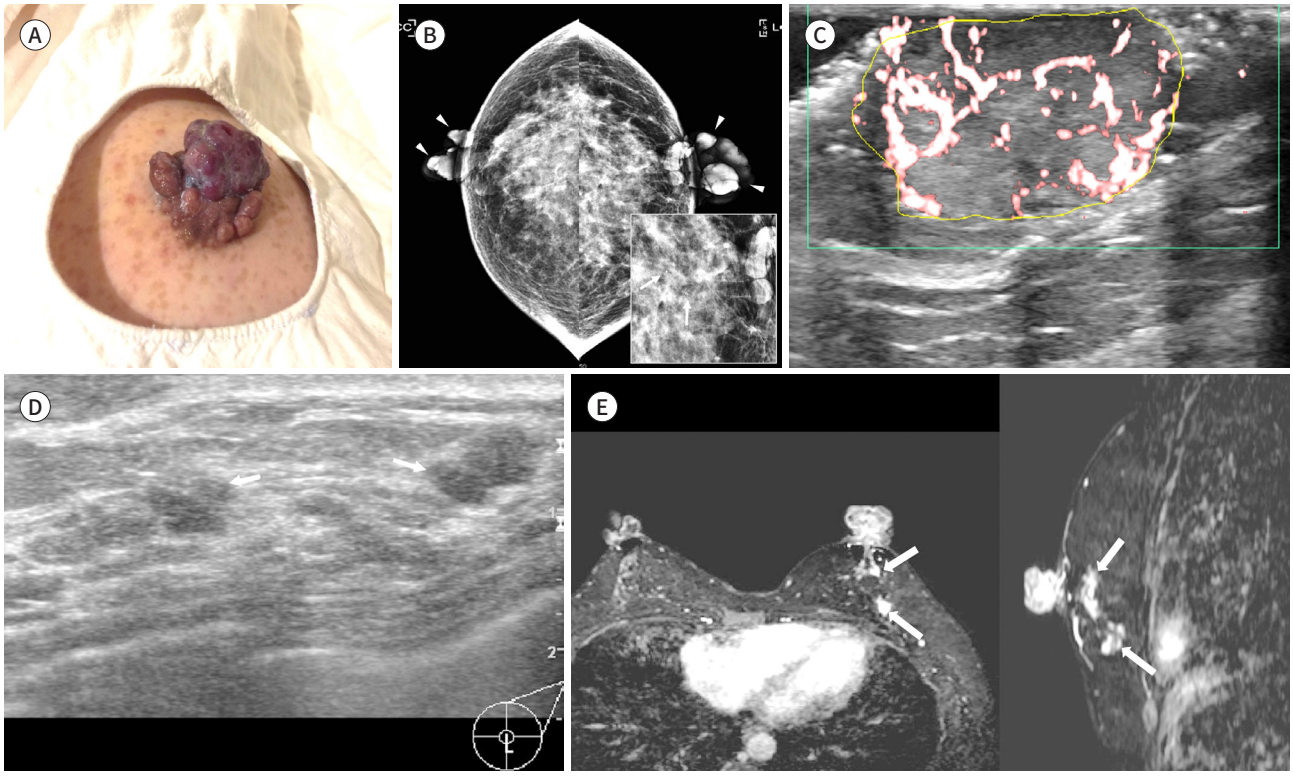
Fig. 5. A 45-year-old woman with neurofibromatosis type I and left breast ductal carcinoma.
A. Multiple café au lait spots in the skin and neurofibromatosis in the nipple represent NF1.
B. Mammography shows irregular lobulated masses (arrowheads) involving the nipple-areolar complex, possibly a cutaneous manifestation of known neurofibromatosis. Focal asymmetry with amorphous microcalcifications (arrows) can also be seen in the left central breast (magnification view).
C. Breast sonography superb microvascular image shows an oval, heterogeneous echoic mass with increased vascularity of neurofibromatosis in the nipple.
D. Sonography longitudinal scan shows irregular hypoechoic masses in the left lower central breast (arrows).
E. Axial and sagittal contrast-enhanced T1-weighted breast MR images show heterogeneously enhancing masses in the left inner central breast (arrows). The patient received left skin sparing mastectomy and the masses were pathologically confirmed to be concurrent invasive ductal carcinoma with ductal carcinoma in situ, and neurofibroma of the nipple.
NF = neurofibromatosis type I



with breast carcinoma or be found at mastectomy sites. They most commonly involve the skin and subcutaneous tissue (31). On mammography, they typically appear as iso-density to high-density masses, whereas on ultrasound, they present as irregular or spiculated masses without microcalcifications. Skin lesions associated with granular cell tumors tend to be firm and can range in color from fleshy to red, often accompanied by skin retraction (1, 31, 32). Owing to their propensity to display suspicious features, most cases are categorized as BI-RADS 4 or higher and require histopathological examination for diagnosis. Approximately 1%–2% of these tumors undergo malignant transformation.

SMOOTH MUSCLE TUMORS

Benign and malignant smooth muscle tumors rarely develop in breast tissue. Leiomyoma is a benign entity, whereas leiomyosarcoma is the malignant counterpart (1, 5). These tumors commonly arise in superficial regions, particularly around the nipple-areolar complex, rath-

er than in the deep breast parenchyma. This predilection for the nipple-areolar complex is believed to be attributable to the presence of smooth muscles in the area.

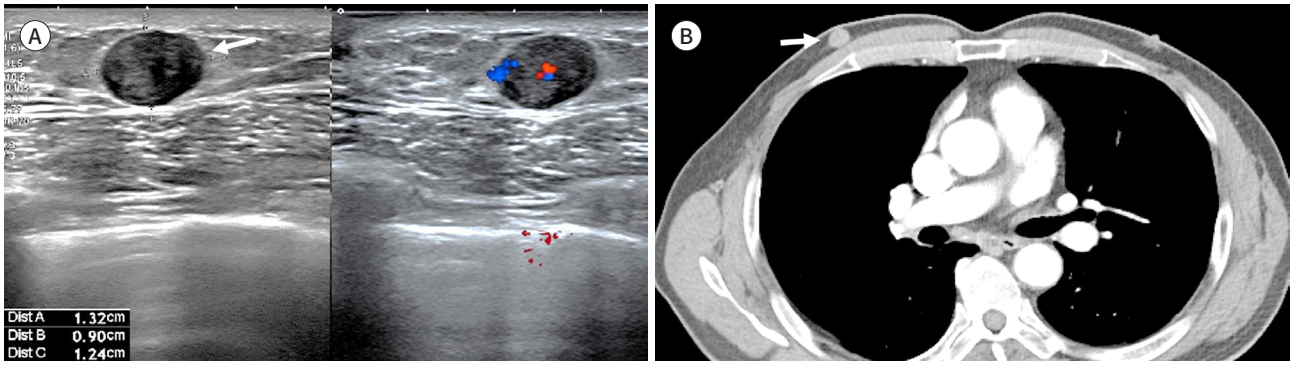
Leiomyoma is a rare tumor of smooth muscle origin that occasionally occurs in the breast. It can be categorized based on its location, as cutaneous (pilar) leiomyoma or leiomyoma of the nipple/areola when it occurs superficially, as leiomyoma of the breast parenchyma when it develops deep within the breast parenchymal tissue (1, 5). It is more commonly found in the superficial nipple areolar complex than in the breast parenchyma. Clinically, parenchymal lesions present as palpable masses with or without pain or discomfort and appear as circumscribed, homogeneous masses without calcifications on mammography and ultrasound (Fig. 6) (33). However, leiomyomas of the nipple/areola may have irregular or spiculated margins and may be associated with skin changes (34). On MRI, leiomyomas usually demonstrate low signal intensity on T1-weighted images, low to intermediate signal intensity on T2-weighted images, and uniform enhancement (35). It is necessary to conduct a biopsy to make a definitive diagnosis; however for lesions with imaging characteristics suggestive of benignity, short-term follow-up may be considered.

Leiomyosarcoma is a malignant tumor with smooth muscle differentiation, and the majority of them arise superficially in the dermis, particularly around the nipple-areola complex (1, 5). Cutaneous leiomyosarcoma often presents as small lesions that are typically less than 2 cm in size, whereas leiomyosarcomas arising in the breast parenchyma are larger, firmer, and well-circumscribed masses (1, 5). In terms of imaging findings, there are no pathognomonic mammographic or ultrasonographic features. On mammography, it may manifest as a focal asymmetry or a mass with associated skin thickening or nipple retraction. On ultrasound, it may appear as a lobulated, mixed, hypo-anechoic, and hypervascular solid mass (36). MRI generally reveals a heterogeneous mass with rapid enhancement and washout kinetics (37). The main differential diagnoses include fibroadenoma, malignant phyllodes tumors, and pseudoangiomatous stromal hyperplasia (PASH).

ADIPOCYTIC TUMORS

Breast tumors with lipomatous or liposarcomatous components are rare. Tumors of differ-

Fig. 6. Leiomyoma in a 72-year-old man with palpable mass in the right breast.
A. US shows a 1.3 cm sized circumscribed, round, hypoechoic mass (arrow) in the right breast subcutaneous periareolar area with focal increased vascularity.
B. Contrast-enhanced chest CT shows a soft tissue density mass (arrow) in the right periareolar area. A small degree of gynecomastia is noted in the left subareolar area.



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ent origins within the breast may exhibit adipocytic differentiation, leading to the presence of fat components, as seen in fibroepithelial tumors and myofibroblastomas (38). True adipocytic tumors in the breast consist of benign entities, such as lipomas, and, angiolipomas, and malignant entities, such as liposarcomas (1, 5).

A lipoma, a common benign tumor composed of mature adipocytes, is a well-circumscribed, mobile, and non-tender mass that shares imaging features across body regions (39). Mammography and ultrasound typically show fat-containing masses with well-defined margins (Fig. 7) (39). Although easily diagnosed through characteristic radiographic features, a rapid increase in size may be considered a sign warranting pathological confirmation.

Angiolipoma is a variant of lipomas characterized by vascular proliferation and usually occurs in the upper extremities, abdomen, and back but rarely in the breast (40). On mammography, it appears as a focal asymmetry (40, 41) and as an isoechoic or hyperechoic mass on ultrasonography (40). The radiographic appearance of angiolipomas often necessitates biopsy owing to the presence of nonspecific imaging features.

Liposarcoma is a malignant soft tissue tumor that originates from lipocytes and develops in the mammary parenchyma or adjacent soft tissues (1, 42). The imaging findings for liposarcomas are nonspecific and can vary based on their histopathological grade, sometimes resembling other benign or malignant tumors, particularly circumscribed and lobulated masses, such as fibroadenomas or phyllodes tumors (Fig. 8). Surgical resection may be recommended because of the possibility of liposarcoma if the lesion composed of fat is very large, soft tissue or solid components are prominent, or if Doppler ultrasound shows increased vascularity (43).

OTHER MESENCHYMAL TUMOR AND TUMOR-LIKE CONDITIONS

PSEUDOANGIOMATOUS STROMAL HYPERPLASIA (PASH)

PASH is a benign condition that is characterized by stromal myofibroblastic proliferation

Fig. 7. Breast lipoma in a 66-year-old woman with a palpable mass in the right breast.
A. Mammography right CC (left) and MLO (right) views show a large, well-defined, fat- containing mass (arrows) in the right upper outer breast.
B. US shows an approximately 6.6 cm sized oval, circumscribed, isoechoic mass (arrows) showing internal hyperechoic linear striations. The lesion was not pathologically confirmed. However, considering the characteristic imaging findings, it was thought to be lipoma.

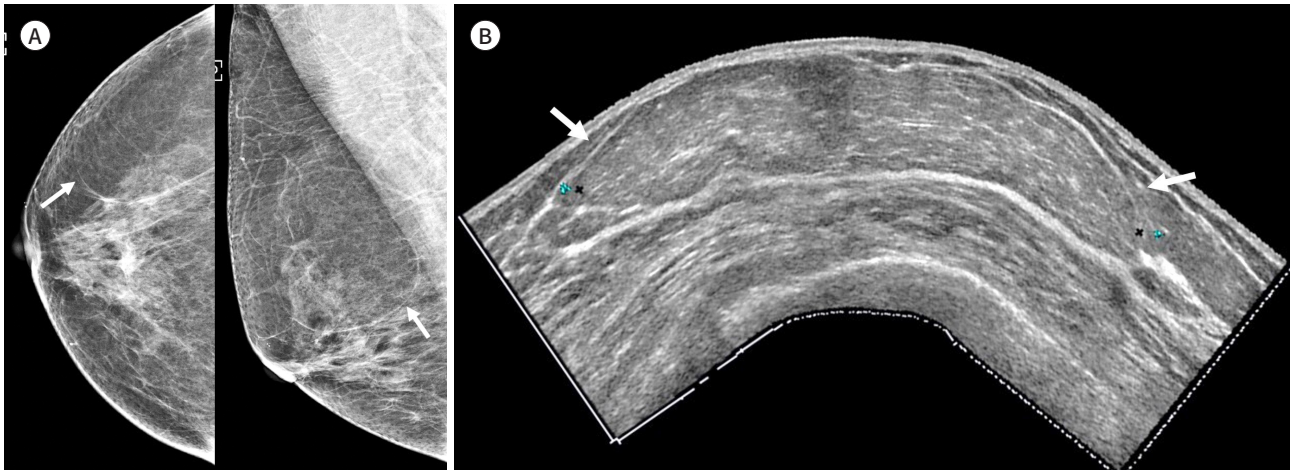


Fig. 8. Atypical lipomatous tumor/well-differentiated liposarcoma in a 44-year-old man with palpable mass on the right chest wall.
A. US shows an oval, circumscribed, isoechoic mass (arrows) between the right pectoralis major and minor muscles.
B. Contrast enhanced chest CT shows a 4.2 cm sized, well-defined, fatty mass (arrow) with internal thin enhancing septa in the right interpectoral space. An excisional biopsy was performed, and the mass was pathologically confirmed as an atypical lipomatous tumor/well-differentiated liposarcoma.

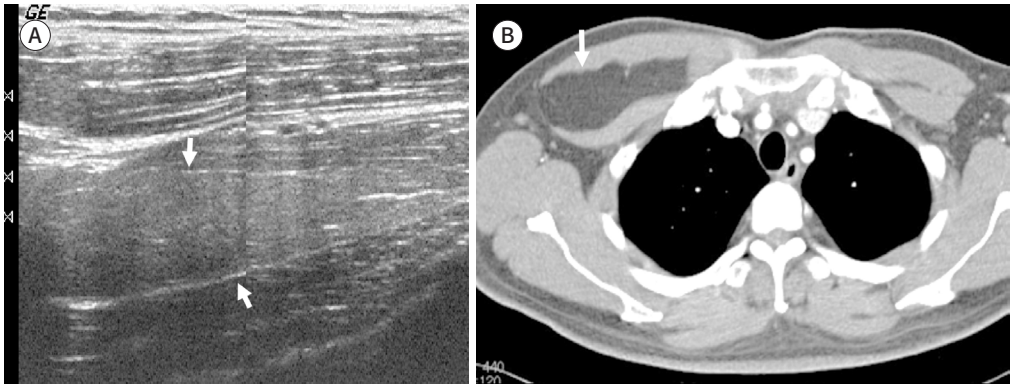
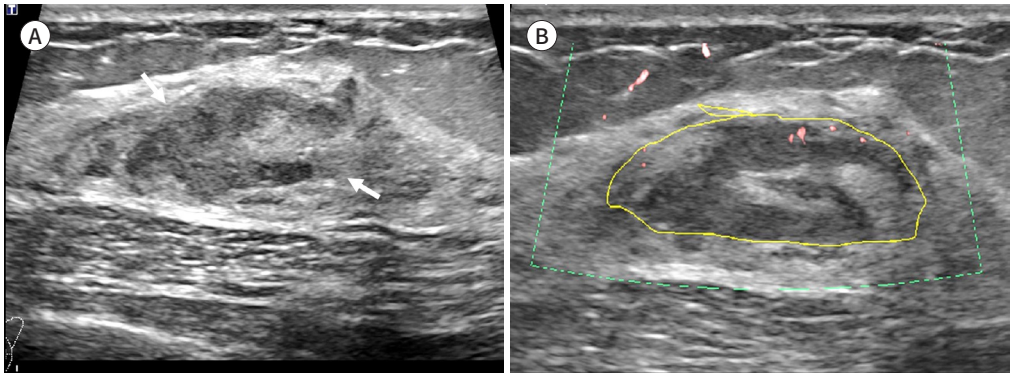


Fig. 9. Pseudoangiomatous stromal hyperplasia in a 47-year-old woman with a palpable mass in the left breast.
A. US image shows an oval, partially circumscribed, and heterogeneous isoechoic mass (arrows) in the left upper inner breast.
B. US superb microvascular image shows slow growth during 4-year follow-up period, and the mass resembles a fibroadenoma.



lining anastomosing slit-like spaces (1, 44). Its etiology remains unknown, and it often involves hormonal associations, particularly with progesterone, along with the proliferative response of myofibroblasts. It is frequently encountered in pre- or post-menopausal women undergoing hormone replacement therapy. PASH can affect both sexes and is often discovered incidentally during evaluation of other benign or malignant breast lesions (45).

The imaging features of PASH vary, ranging from incidental microfoci to mass-forming tumors resembling fibroadenomas on mammography and ultrasonography (Fig. 9) (46). On MRI, it often demonstrates progressive enhancement with high-signal slit-like spaces on T2-weighted images. These slit-like spaces pathologically correspond to empty clefts within the cellular hyalinized stroma (45).

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CONCLUSION

In this pictorial review, we explored the clinical, pathological, and imaging characteristics of lesions representative of six categories of breast mesenchymal tumors. Mesenchymal tumors of the breast are exceedingly rare, and malignant tumors are even less frequent. However, given the potentially significant impact on the prognosis when the diagnosis of certain malignant entities is delayed, it is imperative for clinicians and radiologists to gain a thorough understanding of the clinical and imaging characteristics of these lesions. This comprehensive review is expected to help inform diagnostic approaches for specific and challenging mesenchymal tumors of the breast.

Author Contributions

Conceptualization, C.Y.W.; data curation, L.Y.J., C.Y.W.; formal analysis, all authors; investigation, L.Y.J.; methodology, C.Y.W.; resources, C.Y.W.; software, C.Y.W., L.E.J.; supervision, C.Y.W.; visualization, L.Y.J.; writing—original draft, L.Y.J.; and writing—review & editing, C.Y.W., L.E.J.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

ORCID iDs

Yoon Jung Lee http://orcid.org/0009-0007-4194-3813
Yun-Woo Chang http://orcid.org/0000-0001-9704-8112
Eun Ji Lee http://orcid.org/0000-0002-4860-2495

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WHO 분류에 따른 유방의 중간엽 종양의 영상 소견: 임상화보

이윤정 · 장윤우* · 이은지

유방의 중간엽 종양(mesenchymal tumor)은 유방 간질(mammary stroma)에서 기원한 종양으로, 전체 유방 종양의 약 0.5%–1%를 차지하는 드문 질환이다. 병리학적으로는 양성에서 악성까지 다양한 스펙트럼을 보이며 영상의학적으로는 유방 촬영, 초음파, 및 MRI에서 비특이적인 소견으로 보일 수 있어 종종 진단에 어려움이 있다. 2019년에 발간된 세계보건기구(World Health Organization) 분류 5판에서는 유방의 중간엽 종양을 6가지 범주로 분류하고 있다. 본 임상화보는 위 분류에 따른 6개 범주의 대표적인 병변들의 임상적, 병리학적, 그리고 영상의학적 특징을 살펴보고, 이에 대한 인식을 높여 조기에 진단하는데 도움을 주고자 한다.

순천향대학교 부속 서울병원 영상의학과