Sonography of Axillary Masses
What Should Be Considered Other Than the Lymph Nodes?

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Objective. The purpose of this study was to review the sonographic findings of various axillary masses other than lymph nodes in correlation with other imaging and pathologic findings. Methods. From a sonographic database, we collected interesting cases of axillary masses with pathologic or other imaging corroboration from the last 10 years. Results. Images of various soft tissue masses were reviewed. They included masses associated with accessory breasts (fibroadenomas, hamartomas, fat necrosis, and cancer arising from axillary breasts), other soft tissue masses (lipomas, schwannomas, hemangiomas, fibromatosis, epidermoid cysts, and malignant fibrous histiocytomas), and complications presenting as masses after axillary lymph node dissection (seromas, hematomas, suture granulomas, pseudoaneurysms, and lymphangiectasia). Conclusions. Awareness of the characteristic sonographic findings of various disease entities that cause axillary masses will help in the correct diagnosis of axillary masses. Key words: axilla; non-nodal mass; sonography.

The axilla is a triangular area located between the upper arm and thorax. The clavicle, scapula, and first rib form its borders. The most common palpable axillary masses are lymph node metastases from breast cancer. However, the axilla also contains various mesenchymal tissues such as fat, vessels, and nerves where various disorders can develop. The use of sonography can detect most of these anatomic elements. Particularly, sonography is useful to establish whether a mass is solid or cystic. As a method with low cost, blood flow evaluation capability with Doppler imaging, and real-time guidance capability for interventional approaches, sonography is the first choice for evaluation of an axillary mass.

The aim of this study was to review the sonographic findings and correlative mammographic, computed tomographic (CT), and magnetic resonance imaging (MRI) findings of various soft tissue masses that arose in the axilla other than in the lymph nodes that were confirmed by pathologic examinations or pathognomonic findings on images. Awareness of the sonographic findings of various diseases that cause axillary masses will help in their differential diagnosis.
Sonography of Axillary Masses

Accessory Breast-Related Masses

The overall prevalence of accessory breasts ranges from 0.6% to 6%.1 The occurrence of accessory breasts varies by ethnicity, with the highest prevalence in Japanese populations and the lowest in white populations compared with other groups, and they are found much more frequently in women than men.1,2 Development of mammary tissue in the human embryo begins at 5 weeks’ gestation with the appearance of the bilateral ectodermal milk line extending from the axilla to the inguinal line. As the mammary ridge develops in the thoracic area at 7 weeks’ gestation, the remaining mammary streaks generally regress. However, incomplete involution of excessive dispersion of the mammary streaks can result in the development of an accessory breast along the primitive mammary streaks or in other parts of the body.3 An accessory breast is most commonly located in the axilla and may enlarge during pregnancy or lactation. Sometimes, an accessory breast is difficult to differentiate from extension of normal breast parenchyma toward the axilla, even though the superficial location of the accessory breast and the characteristic mammographic features are helpful.4 The use of mammography can depict an accessory breast as an irregular linear-shaped high-density lesion in the axilla (Figure 1A). On sonography, an accessory breast is typically seen as an echogenic area with the same appearance as that of the normal glandular tissue (Figure 1B). Various lesions, both benign and malignant, that can involve the breast can also occur in ectopic breast tissue. Occasionally, the accessory breast itself may present as a palpable mass that may have monthly premenstrual changes such as tenderness and swelling. The sonographic appearances of these lesions are usually the same as those of the usual breast tissue.

Fibroadenomas

Fibroadenomas are relatively frequent and are the most common benign neoplasms of the breast. They generally appear as well-circumscribed painless masses in young women.5 Fibroadenomas are rarely found in axillary accessory breasts.6 Aughsteen et al6 reported a case of a fibroadenoma in the axillary breast of a 28-year-old woman for whom clinical and mammographic test results were normal. However, a histopathologic examination showed the presence of a fibroadenoma in the accessory breast.6 On mammography, a fibroadenoma can be seen as a non-specific mass (Figure 2A). On sonography, a clearly

Figure 1. Images from a 36-year-old female patient with an accessory breast in the right axilla. A, Mammography shows high density resembling normal breast parenchyma (arrow) in the right axilla. B, On sonography, the axillary breast tissue is seen as a heterogeneous hyperechoic area just below the skin (arrows) with an appearance similar to that of the normal glandular tissue in the pectoral breast.
circumscribed homogeneous solid mass is seen (Figure 2B). On gadolinium-enhanced MRI, enhancement of a fibroadenoma is highly variable and may be dependent on the degree of fibrosis within the tumor. The enhancement is more gradual in fibroadenomas than in cancers, but this finding is not useful in assessment of individual cases (Figure 2C).

**Hamartomas**

Mammary hamartomas of the breast are uncommon benign tumors. The lesions are also known as fibroadenolipomas, lipofibroadenomas, and adenolipomas and are composed of varying amounts of glandular, adipose and fibrous tissue. A hamartoma usually arises intramammarily and could arise in an ectopic site. In the clinical literature, only a few examples of mammary hamartomas that arose in accessory breasts have been described. Clinically, a hamartoma presents as a discrete encapsulated painless mass. The pathognomonic mammographic appearance is a circumscribed mass that consists of both soft tissue and lipomatous elements surrounded by a thin radiolucent zone (Figure 3A). The sonographic findings are variable, but a well-circumscribed oval mass with heterogeneous echogenicity from an accessory breast is usually seen (Figure 3B).

![Figure 2](image-url)
Fat Necrosis
Fat necrosis of the breast is a benign nonsuppurative inflammatory process of adipose tissue that most commonly occurs after trauma. A cascade of cellular events after the initial injury causes varying imaging appearances. After the inflammatory process, fat cells undergo liquefaction necrosis. Subsequent accumulation of foreign body giant cells and fibrosis cause replacement of the fat necrosis with scar tissue or an oil cyst walled off by fibrous tissue. The stage of development of fat necrosis at the time of the examination affects the imaging appearance.

Typically, fat necrosis is clinically occult and is evident only on mammographic or sonographic images. Occasionally, fat necrosis in the inflammatory stage may mimic breast cancer when it appears as a poorly defined or spiculated dense mass that is associated with skin retraction, ecchymosis, and erythema. An oil cyst with eggshell and dystrophic curvilinear calcifications is the typical radiographic appearance of fat necrosis (Figure 4A). On sonography, fat necrosis characteristically is situated near the skin because those sites are the most vulnerable to trauma, and the mass is most commonly solid, although it may be complex or cystic. Borders may be discrete or poorly defined, and the mass may contain echogenic foci that accompany posterior shadowing (Figure 4B). Computed tomography can show lobulated low-density masses containing dense calcifications (Figure 4C). A pathologic examination may reveal the presence of necrotic adipocytes, foreign body giant cells, bands of fibrosis, and calcifications (Figure 4D).

Carcinomas
Although ectopic breasts occur in up to 5% to 6% of women, the presence of a malignancy in these accessory breasts is quite rare. An accessory breast carcinoma is seen as an irregularly shaped spiculated mass with an accessory breast in the axilla, which is seen as a hypoechoic lesion on sonography (Figure 5A). Ectopic breast cancer seems to have a poorer prognosis than cancer in the normal breast parenchyma. Ectopic breast cancer has a tendency to metastasize earlier and more frequently than a carcinoma of the pectoral breast. Most often, a pathologic examination reveals the presence of an infiltrating ductal carcinoma with a ductal structure involving the accessory breast (Figure 5B).
Primary Soft Tissue Masses in the Axilla

Lipomas
Lipomas are benign fatty tumors, although they may occur in any location, including the axilla. The lesions are usually well-defined, sharply margined, homogeneous fatty masses and may contain occasional septations. On sonography, lipomas are usually located in a subcutaneous fatty layer but can locate anywhere, including the intramuscular areas of the axilla (Figure 6A). In addition, the echogenicity is somewhat variable. Computed tomographic attenuation values are highly accurate for diagnosis of fatty tumors. Lipomas have a well-defined margin and characteristic CT attenuation of –90 to –120 Hounsfield units, values that are usually less than or equal to the attenuation of the normal subcutaneous fat (Figure 6B). Lipomas are usually avascular and usually do not show any contrast enhancement on CT. Liposarcomas are typically heterogeneous and infiltrative with...
poorly defined margins. The CT attenuation is usually higher than that of the normal fat, and the lesions show contrast enhancement on postenhancement CT.\textsuperscript{17}

**Hemangiomas**

Hemangiomas are the most common benign vascular tumors. Most often, a hemangioma is superficially located either subdermally or within subcutaneous tissue. Mammographically, a hemangioma appears as a well-circumscribed macrolobulated lesion that may contain calcifications (Figure 7A).\textsuperscript{18} Sonographically, hemangiomas appear as lobulated superficial well-circumscribed solid masses that are predominantly hypoechoic and may contain areas of calcifications (Figures 7B and 8A). Color Doppler sonography can depict high vascularity in the masses (Figure 8B). Magnetic resonance signal intensities are variable, and dynamic gadolinium-enhanced MRI shows delayed enhancement, indicating slow flow within the capillary hemangioma (Figure 8, C–E).

**Figure 5.** Images from a 33-year-old female patient with an invasive ductal carcinoma that developed from an accessory breast. **A,** Sonography of the right axilla shows an irregularly shaped hypoechoic mass with a poorly defined margin (arrow) originating from surrounding accessory breast tissue. **B,** Photomicrograph from core needle biopsy shows an infiltrative carcinoma (arrows) with a ductal structure representing the accessory breast without a definite nodal structure (hematoxylin-eosin, original magnification x40).

**Figure 6.** Images from a 69-year-old male patient with an intramuscular lipoma of the right axilla. **A,** Sonography shows a small well-circumscribed hyperechoic mass (arrow) in the right axilla. The mass is surrounded by the hypoechoic pectoralis major muscle (arrowhead). **B,** Noncontrast CT shows a homogeneous low-density mass (arrow) within the pectoralis major muscle (arrowhead). The CT attenuation was measured as \(-60\) Hounsfield units, suggesting fat.
**Schwannomas**

Schwannomas are benign neoplasms of Schwann cell origin and most frequently occur in the extremities, trunk, and head and rarely present in the axilla. Sonography shows a well-defined oval homogeneous hypoechoic mass with or without posterior enhancement.\(^{19,20}\) Collagen deposit areas appear as a coarse echo texture or as focally increased echogenic areas. An echogenic ring within the mass is rare but a pathognomonic feature of nerve sheath tumors (Figure 9A).\(^{21}\) An echogenic capsule is usually seen, and cystic spaces represent the presence of degenerated portions of the mass. Sonography can provide confirmation of a neurovascular bundle adjacent to the mass (Figure 9B).\(^{22}\) On MRI, the tumor appears as a well-defined mass of intermediate signal intensity on T1-weighted images and as a mass of high intensity on T2-weighted images, with an inhomogeneous central low-signal area and strong enhancement after contrast agent administration (Figure 9, C–E). On T2-weighted images, the peripheral hyperintense signal is due to the presence of myxoid tissue, and the central low signal intensity is due to the presence of fibrocollagenous tissue (Figure 9E).\(^{23,24}\)

**Fibromatosis (Extra-Abdominal Desmoid Tumor)**

Fibromatosis represents a mass of benign invasive fibrous tissue that proliferates in various anatomic areas. The axilla is a common location for these tumors. In one series, 3 of 13 lesions occurred in the chest wall or axilla.\(^{25}\) When a desmoid tumor occurs in the axilla, there may be nerve involvement due to diffuse infiltration by the mass. Fibromatosis tends to invade nearby structures, making total surgical excision difficult. It is usually necessary for patients to receive postoperative radiation therapy, particularly if the tumor is not totally excised. On sonography, fibromatosis appears as an irregular hypoechoic mass with posterior acoustic shadowing and simulates a malignancy (Figure 10A). The mass shows isointensity to surrounding muscle on T1-weighted images (Figure 10B). On fat-suppressed T2-weighted images, the mass shows areas that are lower or higher in intensity than the normal surrounding muscle (Figure 10C). On contrast-enhanced fat-suppressed T1-weighted images, the mass has a poorly defined margin and heterogeneous enhancement (Figure 10D).

**Epidermal Inclusion Cysts**

Epidermal inclusion cysts are often referred to as sebaceous cysts. This term is a misnomer because no evidence exists that the lesions develop from the sebaceous glands. The mass presents as a smooth mobile cutaneous or subcutaneous lump. Epidermal inclusion cysts are well-defined lesions that can be seen as contiguous with the skin on mammography when they occur in the axilla (Figure 11). Sonographically, a cystic mass may be seen as solid, circumscribed, and complex.\(^{26}\) An onion ring appearance with alternating concentric hyperechoic and hypoechoic rings was described as a finding of epider-
Sonography of Axillary Masses

Figure 8. Images from a 40-year-old female patient with a hemangioma in the right axilla. A, Sonography shows a triangular mixed isoechoic and hypoechoic lesion (arrow) in the right axilla. B, Color Doppler imaging shows markedly increased vascularity within the mass. C, Axial T1-weighted MRI shows a lobulated mass (arrow) in the subcutaneous fatty layer of the right axilla. The signal intensity is homogeneously isointense compared with muscles. D, Sagittal T2-weighted MRI shows a lobulated hyperintense mass (arrow) in the right axilla. E, Gadolinium-enhanced sagittal T1-weighted MRI shows a relatively good enhancement of the mass (arrow).
Figure 9. Images from a 28-year-old female patient with a schwannoma in the right axilla. **A**, Sonography shows a well-circumscribed hypoechoic mass (arrow). The coarse echo texture is thought to represent areas of collagen deposition. **B**, Color Doppler imaging shows hypervascularity in the mass. The mass has a connection with the axillary nerve sheath (arrow), giving a dumbbell-like appearance. **C**, Axial T1-weighted MRI shows a small isointense mass (arrow) in the right axilla. **D**, Gadolinium-enhanced axial T1-weighted MRI shows strong enhancement of the mass (arrow) after contrast agent administration. **E**, Coronal T2-weighted MRI shows a peripherally hyperintense mass (arrow) connected to the adjacent axillary nerve (arrowhead). The central portion of the mass shows slightly lower signal intensity compared with the periphery of the mass.
Sonography of Axillary Masses

Epidermal Inclusion Cysts
Malignant Fibrous Histiocytomas

Although rare, primary neoplasms of fibrous tissue, muscle, or fat can occur in the axilla. The tumors classically do not respect soft tissue and muscle planes. They may extend high in the axilla, producing an initial clinical condition related to brachial plexus involvement, or they may spread along the chest wall.

Figure 10. Images from a 15-year-old female patient with fibromatosis in the left axilla. A, Sonography shows an irregular hypoechoic mass with posterior acoustic shadowing. These features mimic breast cancer. B, Axial T1-weighted MRI shows a triangular isointense mass (arrow) in the left axilla. C, Axial fatsaturated T2-weighted MRI shows hyperintensity of the mass (arrow). D, Postenhancement sagittal fat-saturated T1-weighted MRI shows strong enhancement of the mass (arrow). The surface of the mass has a shaggy appearance, indicating the possibility of fibromatosis.
A malignant fibrous histiocytoma (MFH) is the most common malignant soft tissue tumor, representing 24% of all cases of malignant soft tissue tumors.30 Malignant fibrous histiocytomas occur in adults, appear more frequently in men than women, and show a greater predilection for white people than black or Asian people. The lower extremity is the most common site of involvement, followed by the upper extremity and retroperitoneum; an MFH that occurs in the axilla is extremely rare. When a lesion consists of more than 50% myxoid tissue, it is classified as a myxoid MFH.31 A sonographic examination of an MFH, especially for myxoid lesions, often shows the presence of an inhomogeneous mass with hypoechoic intratumoral areas of necrosis and a hyperechoic cellular area (Figure 13A).32 On a Doppler study, the solid portion of the myxoid tissue mass may show increased blood flow. On MRI, an MFH shows nonspecific findings of a soft tissue mass, and there is no correlation between the histologic type and MRI appearance (Figure 13, B–D), except that a myxoid MFH appears less heterogeneous on T2-weighted images.33 For a myxoid MFH, central myxoid areas show low signal intensity on T1-weighted images and high signal intensity on T2-weighted images.

Figure 11. Image from a 37-year-old female patient with an epidermal inclusion cyst in the left axilla. Sonography shows a smoothly marginated mass located in the subcutaneous fat layer just beneath the skin. Internal echogenic material and multiple layers represent layers of sloughed keratin within the cyst (arrow). The claw sign of hyperechoic skin around the edge of the mass, suggesting a skin origin, is not definite in this case because of the large size of the mass.

Figure 12. Images from a 47-year-old female patient with a ruptured epidermal inclusion cyst in the left axilla. A, Doppler sonography shows a heterogeneous hypoechoic mass with an indistinct margin (arrow). The mass has peripherally increased vascular flow. B, Postenhancement coronal CT shows an enhancing mass (arrow) with infiltrative margins in the left axilla. C, Photomicrograph shows multinucleated giant cells containing keratin material (arrows), which is pathognomonic for an epidermal inclusion cyst (hematoxylin-eosin, original magnification ×200).
images. Although the radiologic appearance of most soft tissue masses remains nonspecific, it might be possible to obtain more detailed information if MRI is performed before surgery because the mass contains multiple foci of hemorrhage and myxoid components.

Surgery-Related Masses

Seromas and Old Hematomas
Seromas are the most frequent postoperative complications after removal of the axillary lymph nodes and have been reported to be present in 15% to 85% of patients after axillary lymphadenectomy. Seromas are accumulations of serous fluid that develop in the axillary dead space, and they are usually absorbed within a few weeks.

On sonography, a seroma is seen as just a fluid collection with or without septations or can be seen as a round or oval soft tissue mass (Figure 14). Reabsorption of seroma fluid can be slow, and these masses can persist for many months and occasionally for 2 or more years. Sometimes, when a lesion appears as a complex mass, the findings do not differentiate the lesion from a carcinoma. However, the use of serial sonography can depict whether the lesions decrease or do not change.
not change in size. Moreover, as the lesions regress, fibrosis of the surgical cavity can develop as a scar at the surgical site.

Suture Granulomas
Suture granulomas are rare complications after axillary dissection and can occur anywhere in the body after a variety of surgical procedures. Usually, a suture granuloma occurs after the use of nonabsorbable suture material deep within the skin, especially after abdominal surgery. The reported characteristic sonographic finding of a suture granuloma is the presence of a hypoechoic lesion with hyperechoic double lines (rail-like lines) or a single line (Figure 15). However, differentiation between recurrence and a suture granuloma is not easy on postoperative sonography, and the use of sonographically guided fine-needle aspiration or excision is needed for confirmation. Most often, a pathologic examination reveals islands of amorphous eosinophilic material with an associated foreign body giant cell reaction and foci of dystrophic calcification.

Pseudoaneurysms
To our knowledge, pseudoaneurysms of the axilla have not been reported in the literature, and just a few cases of pseudoaneurysms of the breast have been reported, in which most cases developed after a core biopsy. A pseudoaneurysm is not a true aneurysm because it lacks an arterial wall. It is the result of a puncture or tear of the 3 layers of an arterial wall with extravasation of blood and hematoma formation in the adjacent tissues (Figure 16A). Because a pseudoaneurysm appears on sonography as a complex lesion with an anechoic component, it can be misdiagnosed as a simple hematoma or cystic lesion on gray scale sonography (Figure 16B). However, diagnosis of a pseudoaneurysm is easily obtained with the use of color Doppler sonography because this technique can show the presence of swirling flow in the mass or cavity, which is connected by a track to an adjacent vessel (Figure 16C). Apart from surgical treatment, various interventional procedures such as microcoil insertion, thrombin injection, alcohol injection, and sonographically guided compression have been reported as successful in the treatment of pseudoaneurysms.

Lymphangiectasia
Most lymphangiomas are congenital forms due to malformations of the lymphatic system, and most of these malformations occur in the neck (75%) and axilla (20%). An acquired lymphangioma (lymphangiectasia) can occur after

Figure 14. Image from a 67-year-old female patient with a pathologically confirmed old hematoma in the right axilla from fine-needle aspiration. Six months previously, the patient underwent ipsilateral partial mastectomy and axillary lymph node dissection for invasive ductal carcinoma. Postoperative sonography shows an oval hypoechoic mass in the right axilla (arrow).

Figure 15. Image from a 58-year-old female patient with a pathologically confirmed suture granuloma in the left axilla from excisional biopsy. Two years previously, the patient underwent ipsilateral partial mastectomy and axillary lymph node dissection for invasive ductal carcinoma. Sonography shows a hypoechoic lesion with internal hyperechoic foci at the deep layer of the left axilla.
surgery or radiotherapy because of damage to the draining lymphatic channels. For example, acquired progressive lymphangiomas have been recognized as complications following axillary node dissection and radiotherapy for breast carcinoma. Axillary lymphangiomas may be diagnosed antenatally on the basis of the sonographic finding of a cystic mass, which may be loculated and septated in the area of the axilla (Figure 17A). The lesions are best visualized on MRI. Usually, a lymphangioma may appear as a homogeneous cystic mass without septa or a solid component. Axial T2-weighted MRI shows a mass with homogeneous high signal intensity and marginal enhancement after gadolinium injection (Figure 17, B–D).

Conclusions

Many different pathologic conditions in addition to lymph node enlargement can present as axillary masses. Awareness of the variety of these disease entities and characteristic sonographic findings can aid in correct diagnosis of an axillary mass. The use of color Doppler sonography and correlation of sonographic findings with the features of other imaging modalities, including mammography, CT, and MRI, can provide information about the relationship between the mass and adjacent structures and sometimes provide characteristic findings for specific tumors.

Figure 16. Images from a 42-year-old female patient with a palpable nodule in the right axilla. The patient underwent mass excision, and a pathologic examination revealed dilated vessels with an organizing thrombus and fibrosis, compatible with a pseudoaneurysm. One year previously, the patient underwent partial mastectomy and sentinel lymph node biopsy for breast carcinoma. A, Mediolateral oblique mammography of the right breast shows a small area of nodular density (arrow) in the axilla, which is located close to the axillary vessels. B, Gray scale sonography shows a small hypoechoic nodular lesion (arrow) in the subcutaneous fatty layer of the axilla. C, On color Doppler imaging, the nodular lesion shows intense vascularity and a connection with the superficial axillary vessel. These findings are compatible with a postoperative pseudoaneurysm.
Figure 17. Images from a 69-year-old female patient with an enlarging palpable mass in the left axilla. After mass excision, the final diagnosis was cystic lymphangiectasia with chronic inflammation. Several years previously, the patient underwent ipsilateral modified radical mastectomy and axillary lymph node dissection for Paget disease. **A**, Sonography shows conglomerated variably sized cystic masses (arrows) in the left axilla. Some of the lesions have echogenic debris. On color Doppler imaging, the periphery of the cystic lesions shows mild vascularity. **B**, Axial T1-weighted MRI shows an irregularly shaped isointense mass (arrows) in the left axilla. **C**, Coronal T2-weighted MRI shows a multiseptated hyperintense cystic mass (arrows) in the left axilla. **D**, Gadolinium-enhanced axial T1-weighted MRI shows peripheral and septal enhancement of the multiseptated cystic mass (arrows) after contrast agent administration.
Sonography of Axillary Masses

References


