A review of breast and emergencies may seem mutually exclusive of one another, but breast interventions beyond pathologic diagnosis are encountered and may be urgent. Acute breast situations that can potentially require interventional techniques to resolve include abscess or complications from percutaneous biopsy or trauma such as hemorrhage or pseudoaneurysm. Acute breast interventions are not commonly seen, but a working knowledge of the various treatment approaches and management is important. These entities can be similar to other areas of the body, but there are some specifics to the breast that can allow for optimal treatment and management.

**Abscess**

**Overview**

One of the more common emergent breast pathologies encountered by the interventionalist is breast abscess. A breast abscess is usually a complication of infectious mastitis. Mastitis is an inflammation of the breast, most commonly caused by *Staphylococcus aureus*. As mastitis progresses to an abscess, a defined collection of infected fluid or pus forms. Mastitis and abscess are broadly categorized as either lactating or nonlactating. Lactating mastitis or abscess usually occurs in younger patients, within 3 months of childbirth, whereas nonlactating mastitis or abscess is usually seen in older patients. Abscesses are also encountered in the recently postoperative patient population, whether from mastectomy, lumpectomy, or reconstruction. Yet another group is those with posttraumatic hematoma that later becomes superinfected.

**Clinical Evaluation**

The initial clinical presentation for both mastitis and abscess is focal inflammation, including pain, warmth, and erythema. More generalized symptoms include fever, headache, fatigue, and body aches. A clinically palpable mass can occur with both mastitis and abscess but is suggestive of abscess. The location of the infection can suggest the etiology and also gives clues as to the potential effectiveness of different types of treatment. Inflammation or abscess at or near the site of a surgery is usually a postsurgical complication. A site of known trauma that demonstrates progressive worsening is suggestive of superinfection. Subareolar location is associated with duct ectasia and chronic ductal obstruction. Subareolar infections have a reputation for being difficult to treat, with a high failure rate requiring multiple interventions and not uncommonly surgical excision for complete resolution.

**Imaging**

Imaging evaluation of an abscess is primarily by ultrasound. Ultrasound characteristics of an abscess include a focal collection of variable shape and size, often with posterior acoustic enhancement. The collection is usually hypoechoic, but hyperechoic mobile debris, internal septations, and air with dirty shadowing can be seen in the collection (Fig. 1). The associated inflammation can lead to a thick echogenic rim and increased vascularity surrounding the collection on color flow imaging, but there is no internal vascularity. Alternatively, findings of tissue heterogeneity and dilated ducts without a focal fluid collection are consistent with mastitis rather than abscess. A breast abscess can also be identified by computed tomographic (CT) or magnetic resonance imaging (MRI) as a rim-enhancing fluid collection. Although neither modality would be first line, an abscess could incidentally
be identified on an emergent CT or as a postbiopsy or implant complication on MRI. Regardless, a sonographic correlate should be identified, as image-guided treatment is typically guided by ultrasound. Mammography should also be pursued in any case that does not resolve after adequate treatment, to exclude underlying malignancy. Histologic diagnosis should be performed if suspicious findings such as microcalcifications are identified or if symptoms do not resolve despite treatment.1,6

Treatment
Oral antibiotics should be included in the treatment of any abscess. Antibiotics should be tailored based on cultures of abscess aspirate material but are often begun empirically.1 Some empiric choices include dicloxacillin 500 mg orally 4 times daily or cephalaxin 500 mg orally 3 times daily. For patients with a penicillin allergy, options include clindamycin 300-450 mg orally 4 times daily, doxycycline 100 mg orally twice daily, or trimethoprim-sulfamethoxazole 160/800 mg orally twice daily. However, doxycycline should not be given if the patient is breast-feeding, and trimethoprim-sulfamethoxazole should not be taken if the breast-fed infant is younger than 2 months.

Aspiration
Ultrasound-directed aspiration is the first-line interventional treatment for breast abscess. Abscesses less than 3 cm in size have the highest success rate, but aspiration should be attempted with all sizes.1,4 Equipment includes a high-frequency ultrasound probe (7.5-12 MHz), local anesthetic, 18- or 16-gauge needles or both, syringe, and saline flushes. Standard size needles usually suffice, but longer spinal needles may be necessary in a larger breast with a deeper collection. Depending on the size of the collection, a stopcock and tubing may also be beneficial. For abscesses larger than 3 cm, direct instillation of an injectable antibiotic suspension into the abscess cavity can be beneficial. Ice pack and positioning wedge can aid in patient comfort and optimal positioning.

The patient is positioned supine and a positioning wedge cushion can add obliquity that will allow an optimal approach to the abscess. The nipple and areola should be avoided. Breast abscesses are usually very tender. An ice pack can be applied before any intervention for pain relief and numbing. A local anesthetic such as lidocaine should be administered before aspiration with generous anesthetic applied to the abscess capsule. An 18-gauge needle is advanced into the collection with ultrasound guidance utilizing an oblique tract to reduce fistula formation.7 The fluid is completely aspirated. A larger gauge needle may be needed for thicker more purulent collections to completely drain the cavity.4,5 If the collection is large, the aspirate can be siphoned away with a stopcock and tubing without having to lose initial access to the collection. The aspirate should always be sent for microbiological analysis to help direct antibiotic therapy.1,3-5 The cavity is flushed with saline until the aspirate is clear. Antibiotics can be directly instilled into the cavity, which has shown a higher success rate, particularly in patients with abscesses larger than 3 cm.1 Some examples include cephradine 1 g or gentamicin 40-160 mg, depending on the size of the collection.1 Intracavitary infusion of antibiotics can also be done if follow-up aspiration is needed, using culture results to guide antibiotic choice.4

Clinical and ultrasound follow-up is performed at intervals of 7-14 days with continued oral antibiotics until symptoms resolve. Given the high success rate for lactating abscesses, clinical follow-up alone can be done with ultrasound only if symptoms recur or worsen.1 Aspiration can be repeated several times if the abscess persists on follow-up examinations, with some researchers suggesting up to 5 repetitions before pursuing alternative treatment.1,4,5 Success rates for percutaneous aspiration ranges from 54%-100%.1

Catheter Placement
When aspiration fails, or in the setting of larger abscesses, another treatment option is the placement of an indwelling catheter. Necessary equipment is similar to that required for aspiration, with the addition of a no. 11 blade, 5-8-F catheter with introducer of choice, and a retention device. There are a variety of catheter and introducers to choose from, including a peel-away sheath needle with catheter; the trocar technique with catheter, cannula, and needle combined; and the more traditional Seldinger technique with needle access followed by wires, dilators, and catheter placement. Given the generally superficial location of a breast abscess, the peel-away sheath needle and catheter, or trocar technique usually suffice and reduce the multiple steps and equipment needs of the Seldinger technique.

Positioning, ice pack, and local anesthesia are similar to the aspiration technique. The nipple and areola, as well as the infected area, should be avoided for entry of the catheter. Final position of the external drainage catheter may dictate the approach, but a longer path to the abscess can potentially transect more ducts. This is of particular concern in a lactating female in whom a milk fistula would ultimately lead to cessation of breast-feeding. This possibility should be included in the informed consent process.
Following local anesthesia, a skin nick is made. Access to the abscess is obtained by a trochar and catheter, or peel-away sheath needle with ultrasound guidance (Figs. 2-4). Appropriate position in the abscess is confirmed with ultrasound, and either the trochar is removed leaving the catheter or the catheter is placed through the peel-away sheath and the sheath is removed (Figs. 5-10). The collection is aspirated and irrigated with saline (Figs. 11 and 12). The aspirate should be sent for culture if it has not already been cultured. The catheter is secured at the skin with a retention device.

Most patients can be managed as outpatients. The patient should be instructed to irrigate the abscess 3-4 times a day with saline. Follow-up is generally every 2-3 days but can be extended as the patient progresses. Follow-up evaluation of the residual cavity is performed with ultrasound or fluoroscopically following contrast injection. Ultrasound is generally preferred given the absence of radiation. The catheter is removed once there is minimal output (<4 ml) and the abscess cavity is no longer visible on ultrasound.\(^5\) If the abscess recurs, aspiration or catheter placement can be repeated. Catheter placement has a similar success rate to repeat ultrasound-guided aspirations, but there is added discomfort and a higher risk of fistula.\(^1\) With lactating abscesses, breast-feeding can continue after catheter placement. However, significant milk in the aspirate indicates duct injury, and breast-feeding must be discontinued. Otherwise, the abscess space will fill whenever the patient lactates, preventing collapse and healing of the abscess, and leading to reinfection.\(^5\)

**Incision and Drainage**

If aspiration and catheter placement fail, referral for surgical incision and drainage (I&AD) is indicated. This had previously been the first line of treatment, but greater scarring, the need for general anesthetic, and open packing for approximately 6 weeks have made it a less desirable option.\(^1,3\) The recurrence rate also remains relatively high after surgical I&AD (28%).\(^1,3\) Patients with nonlactating abscesses are more likely to require I&AD, as well as those with larger abscesses and longer-standing symptoms before initial treatment.\(^3\)
Breast Hemorrhage and Hematoma

Overview

Breast hemorrhage and hematoma can be encountered following percutaneous biopsy, with acute trauma, or very rarely, from a tumor eroding into a vessel. Bleeding following a percutaneous biopsy is normal, but should generally resolve after 5-10 minutes of manual pressure. Hemorrhage is considered excessive when it extends beyond this time. Continued manual pressure for 30-60 minutes, injection of lidocaine with epinephrine for vasoconstriction, and pressure bandages would usually resolve excessive bleeding. In the rare instance that these do not suffice, referral for surgical or interventional management is necessary.

Although a variety of acute penetrating or blunt trauma can lead to excessive bleeding or active extravasation in the breast, the most common etiology is from a motor vehicle accident and seat belt injury. The rapid deceleration caused by the seat belt in a vehicular accident can cause a compression or shear-type injury, or even breast avulsion characterized by complete loss of blood supply to the breast. A 3-point harness-type seat belt usually crosses over the medial breast, at the upper inner left and lower inner right on the driver side and upper inner right and lower inner left on the passenger side. However, the location and degree of injury depends on multiple variables including body habitus, seat belt position, impact velocity, and the presence or absence of air bags.

Hemorrhage from a locally advanced eroding tumor in the breast is rare but is encountered. Large friable vessels related to neovascularization can make surgical ligation difficult. These patients are also more likely to have advanced disease and more comorbidities, making interventional management optimal to surgery.

Excessive bleeding in the breast, regardless of etiology, can generally be managed with manual compression. Surgical intervention is usually considered the next line

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Figure 6  The tip of the 5-F catheter is seen advancing through the needle inside the abscess.

Figure 7  The catheter is seen exiting the tip of the peel-away sheath after removing the needle. (Color version of figure is available online.)

Figure 8  The pigtail catheter is fully deployed in the abscess. Once adequate positioning is confirmed, the peel-away sheath is removed.

Figure 9  Pigtail catheter is shown through the peel-away sheath. (Color version of figure is available online.)
of treatment. However, interventional radiology is increasingly involved in cases of emergent hemorrhage, and has been used to treat hemorrhage involving the breast.

**Clinical History**

A patient presenting with breast hemorrhage or hematoma significant enough to require intervention will usually have recent history of percutaneous biopsy or acute trauma with hemorrhage that cannot be controlled with manual pressure. Physical examination demonstrates an acutely tender breast. Extensive bruising can both involve the affected and opposite breast, chest wall, and flank. A palpable lump may be present or rapid enlargement of the entire breast (Fig. 13). In the case of percutaneous biopsy or penetrating injury, there may be active bleeding at the entry site. With seat belt injury, the friction on the skin can cause blistering and ulceration, or acute compression can cause a focal furrow appearing to divide the breast. Hemorrhage from a seat belt injury may be delayed owing to vasoconstriction from the initial injury. Hemorrhage from a locally advanced breast mass may have overlying skin changes including retraction, skin thickening, and cutaneous ulceration at the tumor site.

**Imaging**

In the postbiopsy setting, hemorrhage or hematoma may be identified mammographically or by ultrasound.

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**Figure 10** Peel-away sheath is removed, leaving the pigtail catheter in place. (Color version of figure is available online.)

**Figure 11** The abscess collection decreases in size as the purulent fluid is aspirated.

**Figure 12** The abscess is irrigated with saline.

**Figure 13** Postbiopsy hemorrhage has led to significant asymmetric enlargement of the left breast and bruising extending over the left breast and down the side and flank. (Color version of figure is available online.)
However, uncontrolled hemorrhage or hematoma is determined by the clinical symptoms described previously, and not the mammographic or ultrasound appearance. In the setting of acute trauma and seat belt injury, a CT trauma scan with intravenous contrast is often the initial evaluation. A hematoma will appear as a hypodense collection, and active extravasation is indicated by a blush of contrast in the collection (Fig. 14).

Fluoroscopic angiography can confirm ongoing hemorrhage as a blush of contrast extending outside of the arterial lumen. It can also further characterize the location by mapping the exact blood supply.\textsuperscript{15}

Treatment

As previously stated, the initial treatment for most cases of hemorrhage and hematoma is manual pressure. When manual pressure fails, more invasive methods can be employed, including intravascular embolization. Necessary equipment includes an arterial access kit, guidewire, microcatheter, contrast, syringes, and embolic agent. Coils, glue, particles, and gelfoam can all potentially be used in the breast, but a gelfoam slurry is generally preferred as it is a temporary agent and recanalization is possible.\textsuperscript{16} However, some vessels are too small to select and inject gelfoam, and other embolic choices are better options.

The patient is steriley prepared, and arterial access is gained. Angiography is performed by standard methods. The primary blood supply to the breast (60%) is from the second to fifth superomedial perforators of the internal thoracic artery via the subclavian artery. The remaining blood supply is from the lateral thoracic artery via the axillary artery, the thoracromial artery, and branches of the serratus anterior and intercostal arteries.\textsuperscript{12,16} Subselection of arteries with a steerable microcatheter may be necessary to identify the area of active extravasation. Once identified and subselected, gelfoam slurry or other embolic material is slowly injected. The most effective technique involves positioning the catheter distal to the extravasation, if possible, and slowly retracting across the area of extravasation while injecting to achieve stasis.\textsuperscript{16}

If gelfoam cannot be used, other methods include proximal embolization with pledgets, glue, or coils.\textsuperscript{12,13,16} Another method used for vessels that cannot be subselected, involves placing a microcoil just distal to the origin of the bleeding vessel, injecting microspheres (diameter of 500-700 $\mu$m), and then placing an additional microcoil just proximal to the origin.\textsuperscript{14}

Follow-up is not well established for hemorrhage in the breast. Monitoring in the acute setting includes monitoring the blood pressure and hemoglobin and hematocrit levels. In less complicated cases, the patient should be instructed to monitor for recurrent symptoms such as increasing lump or overall breast size.

Some situations are better delegated to surgical management. In the rare case of breast avulsion, hemorrhage can be so rapid, immediate surgical intervention is usually necessary.\textsuperscript{10} Percutaneous biopsy can cause an arterial shearing injury with removal of a portion of the arterial wall rather than complete transsection. When the vessel attempts to constrict in response to the injury, the residual wall prevents collapse of the vessel, resulting in prolonged bleeding. Although clotting may be achieved by manual pressure or embolic material, the risk of the clot or emboli becoming dislodged is higher. Surgical ligation should always be a consideration, particularly with recurrent bleeding.

Pseudoaneurysm

Overview

A breast pseudoaneurysm usually occurs secondary to trauma, including trauma from a percutaneous biopsy. A pseudoaneurysm is a contained hematoma with a neck that communicates with the lumen of an artery and usually contains flowing blood.\textsuperscript{17-19} Unlike a true aneurysm, a pseudoaneurysm does not have the normal 3 layers of the arterial wall.\textsuperscript{17,19} Spontaneous formation of a pseudoaneurysm has been reported, primarily in patients with underlying atherosclerotic disease or patients on anticoagulants or both.\textsuperscript{18,19} Spontaneous resolution of breast pseudoaneurysms has also been reported.\textsuperscript{17-20} It is theorized that small pseudoaneurysms may be more common than initially thought, but that small size, small neck, and absence of underlying anticoagulation lead to spontaneous resolution before clinical identification.

Clinical History

Pseudoaneurysm should be suspected when a patient presents with a palpable pulsatile breast mass. The size can be variable, but usually ranges from 1 to 3 cm.\textsuperscript{19,21} Extensive cutaneous bruising may be seen in the surrounding area on physical examination.\textsuperscript{19} There is often a history of recent breast trauma or biopsy, especially one
accompanied by extensive bleeding or hematoma formation.18-20

**Imaging**

Ultrasound is the primary form of imaging for both identifying and treating a pseudoaneurysm. A pseudoaneurysm may be identified by mammography as a circumscribed mass adjacent to or extending from a blood vessel,20 but ultrasound will be necessary to confirm that the mass represents a pseudoaneurysm. The sonographic appearance includes an anechoic mass with echogenic rim, adjacent to an artery19,20 (Fig. 15). Color and power Doppler imaging will show the adjacent artery, connecting neck, and communicating blood flow within the pseudoaneurysm.17-19,21 The turbulent flow in the pseudoaneurysm can have the classic “ying-yang” or swirling pattern on color Doppler imaging, and the spectral Doppler imaging will show the “to-and-fro” wave form caused by the pressure changes from systole to diastole18,19,21,22 (Figs. 16 and 17). Once clot has formed in the pseudoaneurysm, it may continue to have a hypoechoic appearance, but blood flow will be absent.

A pseudoaneurysm may also be identified on angiography, whether fluoroscopically, by CT or by MRI, as a focal outpouching with a neck communicating with an artery.

**Treatment**

There are multiple methods for treating a pseudoaneurysm in the breast. The broad categories include manual pressure, thrombosis by injection, intravascular embolization, and surgical repair.

The first-line treatment is ultrasound-guided manual compression.19-21 This can often be done at the time of initial imaging and detection. Manual pressure is applied to the neck of the pseudoaneurysm with ultrasound guidance for a minimum of 20 minutes and up to 60 minutes. Pressure is released and the pseudoaneurysm is reassessed with Doppler imaging to look for any residual flow.17,21 The process can be repeated until thrombosis is observed. Follow-up ultrasound imaging 2-7 days after the procedure should be performed to ensure and document continued thrombosis.
Although first line, manual pressure has a lower success rate treating pseudoaneurysms in the breast compared with other locations in the body. This may, in fact, be a misconception given the relative rarity of breast pseudoaneurysms, and perceived lower success rates dependant on a few case reports. However, suggested reasons for poorer outcomes in the breast include a higher occurrence of wide neck pseudoaneurysms owing to large gauge biopsy devices, difficulty achieving and maintaining adequate pressure given the pliability of the breast, and mobility of breast tissue disrupting early thrombus formation. Early treatment seems to be associated with a higher success rate.

Treatment of a breast pseudoaneurysm by injection of thrombosing material is usually considered second line once manual compression has failed. Some argue injection of thrombosing material should be first line given the amount of time required for manual compression. Equipment needed for injection of thrombosing material includes a high-frequency ultrasound probe, local anesthetic, a small needle (18-27 gauge), and a thrombosing agent such as thrombin or 95% alcohol.

Initial preparation includes the standard practice of optimal positioning, sterile preparation of the skin, and injection of a local anesthetic. The pseudoaneurysm is then accessed with a small (18-27 gauge) needle using ultrasound guidance (Fig. 18). Owing to the infrequency of these lesions, there is no recommended dosing, but as in other locations, thrombin concentrations ranging from 20-1000 U/cc may be attempted. Needle placement should be in the periphery of the pseudoaneurysms away from the neck, and approximately 0.2-1.0 ml of thrombin is slowly injected over several seconds. Applying pressure to the neck of the pseudoaneurysm while injecting thrombin can also help prevent reflux into the artery. Thrombosis is confirmed with ultrasound color flow imaging (Fig. 19).

There is a slight variation in technique when attempting thrombosis with 95% alcohol. The artery supplying the pseudoaneurysm should clearly be identified sonographically. The feeding and draining aspects should be compressed before injection. The pseudoaneurysm is accessed as with thrombin injection, and approximately 1 ml of 95% alcohol is slowly injected. Compression of the artery should be continued for 30 minutes to prevent alcohol reflux into the artery and allow thrombosis.

A third option is ultrasound-guided placement of a microcoil to achieve thrombosis. Additional equipment includes a 3-F micropuncture kit and a microcoil sized to the pseudoaneurysm. The pseudoaneurysm is accessed with ultrasound guidance and the microcoil is placed into the lumen of the pseudoaneurysm. Thrombosis is confirmed with color Doppler ultrasound.

Intravascular embolization of a pseudoaneurysms is usually required in the setting of significant hemorrhage. When evaluating the hemorrhage with fluoroscopic angiography, a pseudoaneurysm can be identified and treated. Treatment is similar to embolization for hemorrhage, with gelfoam, glue, or coils deployed intravascularly to limit blood flow to the pseudoaneurysm and to allow it to thrombose.

It is important to identify situations in which a patient with a pseudoaneurysm should be referred for surgical repair. A good example is a postbiopsy pseudoaneurysm with a histologic diagnosis requiring surgical excision. As breast surgery is already planned in the region of the pseudoaneurysm, surgical management of both the lesion and pseudoaneurysm is more practical. Failed percutaneous treatment is another indication for surgical repair of a pseudoaneurysm.

**Conclusion**

Urgent breast interventions are uncommon, but familiarity with possible problems allows for optimal and timely treatment. Most cases are initially going to be encountered...
by a breast imager or in the emergency department, and present to the interventionalist when less invasive treatments have failed. Breast abscess is the most common situation encountered. Pseudoaneurysms, hemorrhage, and hematoma are more commonly seen elsewhere in the body but can occur in the breast as well. Knowledge of the usual presentation of these entities and interventional management options will allow for optimal patient care.

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References