RadioGraphics

Breast Abscesses: Evidence-based Algorithms for Diagnosis, Management, and Follow-up[1]

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CME FEATURE

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LEARNING OBJECTIVES FOR TEST 5

After completing this journal-based CME activity, participants will be able to:

- Discuss the role of the radiologist in management of breast abscesses.
- Recognize the different types of breast abscesses and the management challenges particular to each type.
- Describe a radiologic algorithm for treatment and follow-up of breast abscesses.

TEACHING POINTS

See last page

Radiologists who regularly perform breast ultrasonography will likely encounter patients with breast abscesses. Although the traditional approach of surgical incision and drainage is no longer the recommended treatment, there are no clear guidelines for management of this clinical condition. Breast abscesses that develop in the puerperal period generally have a better course than nonpuerperal abscesses, which tend to be associated with longer treatment times and a higher rate of recurrence. The available literature on treatment of breast abscesses is imperfect, with no clear consensus on drainage, antibiotic therapy, and follow-up. By synthesizing the data available from studies published in the past 20 years, an evidence-based algorithm for management of breast abscesses has been developed. The proposed algorithm is easy to follow and has been validated by a multidisciplinary team approach and applied successfully during the past 2 years. Breast abscesses are a challenging clinical condition, and radiologists have a pivotal role in evaluation and follow-up of these lesions.

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Introduction

Breast abscesses are complications of infectious mastitis and generally occur in young women. Because traditional treatment with surgical incision and drainage is no longer recommended as a first-line approach, the role of the radiologist has increased to include the need to identify and characterize these infectious collections as well as perform percutaneous drainage and follow-up evaluations. As a result, the radiologist has truly become part of the treatment team. Few data are available on guidelines for management of breast abscesses, and treatment options vary in the literature, with no established consensus on drainage and antibiotic treatment.

The goal of this article is threefold: *(a)* to review the classification and pathophysiology of breast abscesses, *(b)* to describe the radiologic investigation of abscesses and compare the efficacy of different treatment alternatives described in the literature, and *(c)* to propose a treatment algorithm validated by a multidisciplinary team.

Classification of Breast Abscesses

Breast abscesses can be classified according to clinical presentation, location, or pathogenic organism. Most abscesses result from secondary bacterial infection from skin contamination. Although *Staphylococcus aureus* is by far the main pathogen, other microorganisms can be encountered, for example *Staphylococcus epidermidis*, *Streptococcus pyogenes*, and anaerobes such as *Peptostreptococcus* and *Bacteroides* (1). A sterile culture with absent growth of bacteria is reported in 21%–45% of cultures, although this may be a false-negative finding due to previous treatment with antibiotics (2–4). Less commonly, in specific clinical settings, breast infections secondary to tuberculosis and other mycobacteria, fungi, or parasites can occur.

For clinical relevance and treatment management, it is most useful to classify abscesses according to clinical presentation.

Puerperal Abscesses

Mastitis is a complication most often encountered in primiparous women and develops in 1%–24% of breast-feeding women (5). Breast abscesses develop as a complication of mastitis in 5%–11% of cases (6), generally in the first 12 weeks after birth or at the time of weaning (7), and are referred to as puerperal or lactational abscesses. They are caused by bacteria—most often *S aureus*—that enter via a small skin laceration and proliferate in the stagnant lactiferous ducts. This type of abscess is more frequent in primiparous mothers (65% of cases) (5,8) and responds well to drainage and antibiotics (Fig 1).

Teaching Point

Women should be encouraged to continue breast-feeding throughout treatment to disengorge the ducts. Cessation of breast-feeding is necessary only when treatment with an antibiotic contraindicated for the newborn is prescribed (eg, tetracycline, ciprofloxacin, or chloramphenicol) or if surgical drainage is performed.

Nonpuerperal Abscesses

Breast abscesses that occur outside of the breast-feeding period are termed *nonpuerperal* and are categorized according to location, either central (periareolar) or peripheral. Risk factors for the development of breast abscesses include black race, obesity, and tobacco smoking (9). In addition, Rizzo et al (10) recently reported that 64% of 87 women with nonlactational abscesses who were treated were diabetic, although the importance of this risk factor could be partly confounded by the fact that 89% of women in their study were black, another independent risk factor for nonlactational abscesses.

Central (Periareolar) Nonpuerperal Abscess.— Central nonpuerperal abscesses are the most common form of abscesses that develop outside of the breast-feeding period. They primarily affect young women, most of whom are smokers (1,4,11) (Fig 2). With the increasing use of tobacco by young women, this type of abscess is becoming more frequent (4).

Teaching Point

Figure 1. Puerperal abscess in a 31-year-old woman who noticed reddish discoloration in the lower inner quadrant of the left breast while breast-feeding her infant. After initial treatment with warm compresses, she was referred for US evaluation owing to lack of clinical improvement. **(a)** US image shows a heterogeneous slightly irregular collection that measures 4.3 × 4.1 × 2.0 cm (total volume = 18 mL), thus confirming the clinical suspicion of an abscess. **(b)** US image shows aspiration with an 18-gauge needle, which yielded 14 mL of thick yellowish material. The aspirate was sent for culture. **(c)** US image obtained after aspiration shows that the size of the collection is markedly decreased, with a residual hypoechoic area of inflammation. The patient was prescribed cloxacillin for a total of 10 days and instructed to return for reevaluation. Follow-up US peformed 14 days later showed clinical improvement of the abscess. Cultures showed growth of *S aureus* sensitive to cloxacillin. **(d)** Follow-up US image shows a decrease in the size of the collection, which now measures 2.4 × 1.6 × 0.8 cm (volume = 2 mL). Owing to the presence of a small anechoic central component, repeat aspiration was performed, which yielded 2 mL of pus. An additional course of antibiotic was prescribed and the patient was instructed to return 4 weeks later, unless symptoms worsened. **(e)** Repeat US image obtained in a now asymptomatic patient 6 weeks after initial presentation shows hardly discernible US abnormalities.

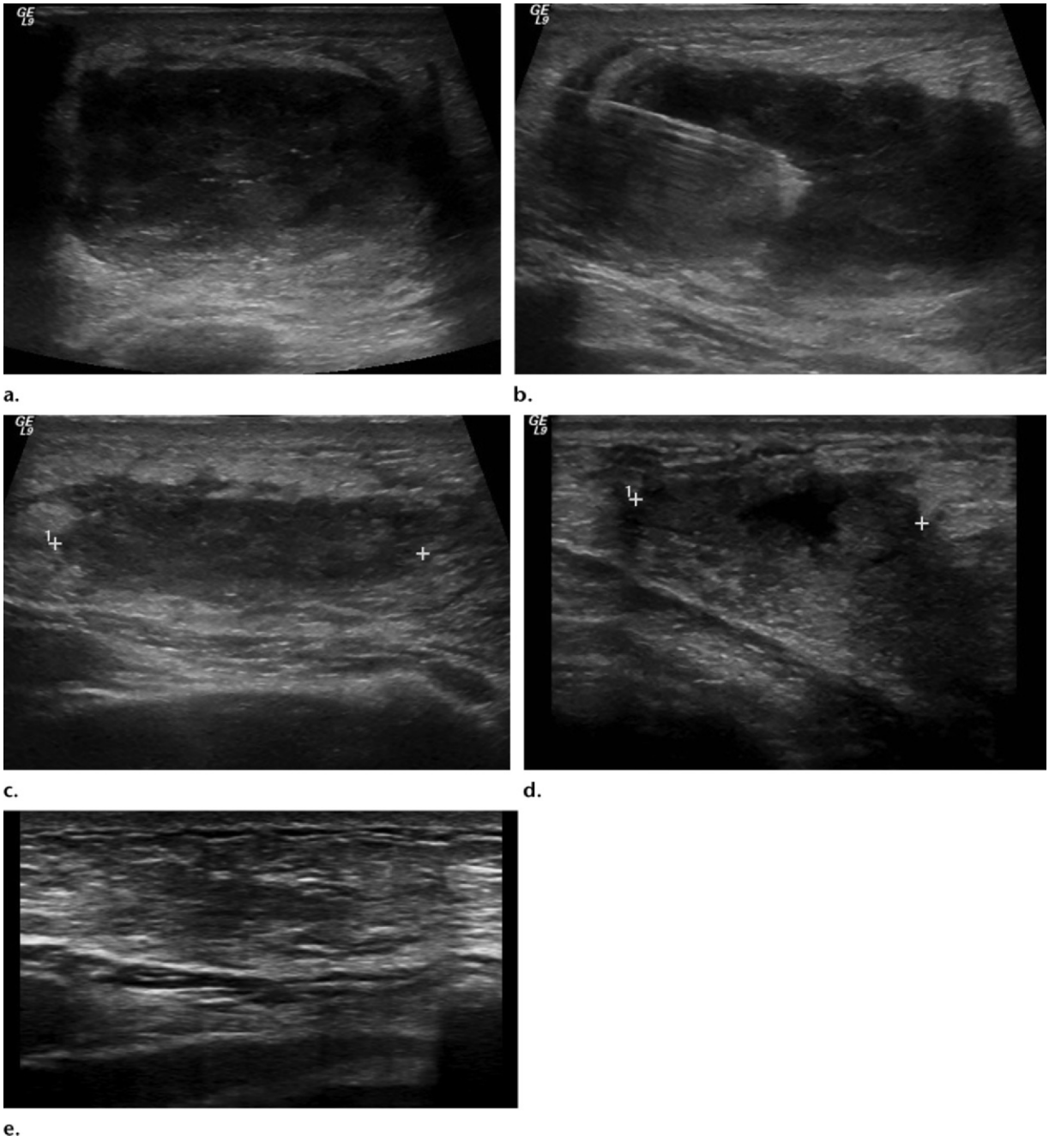
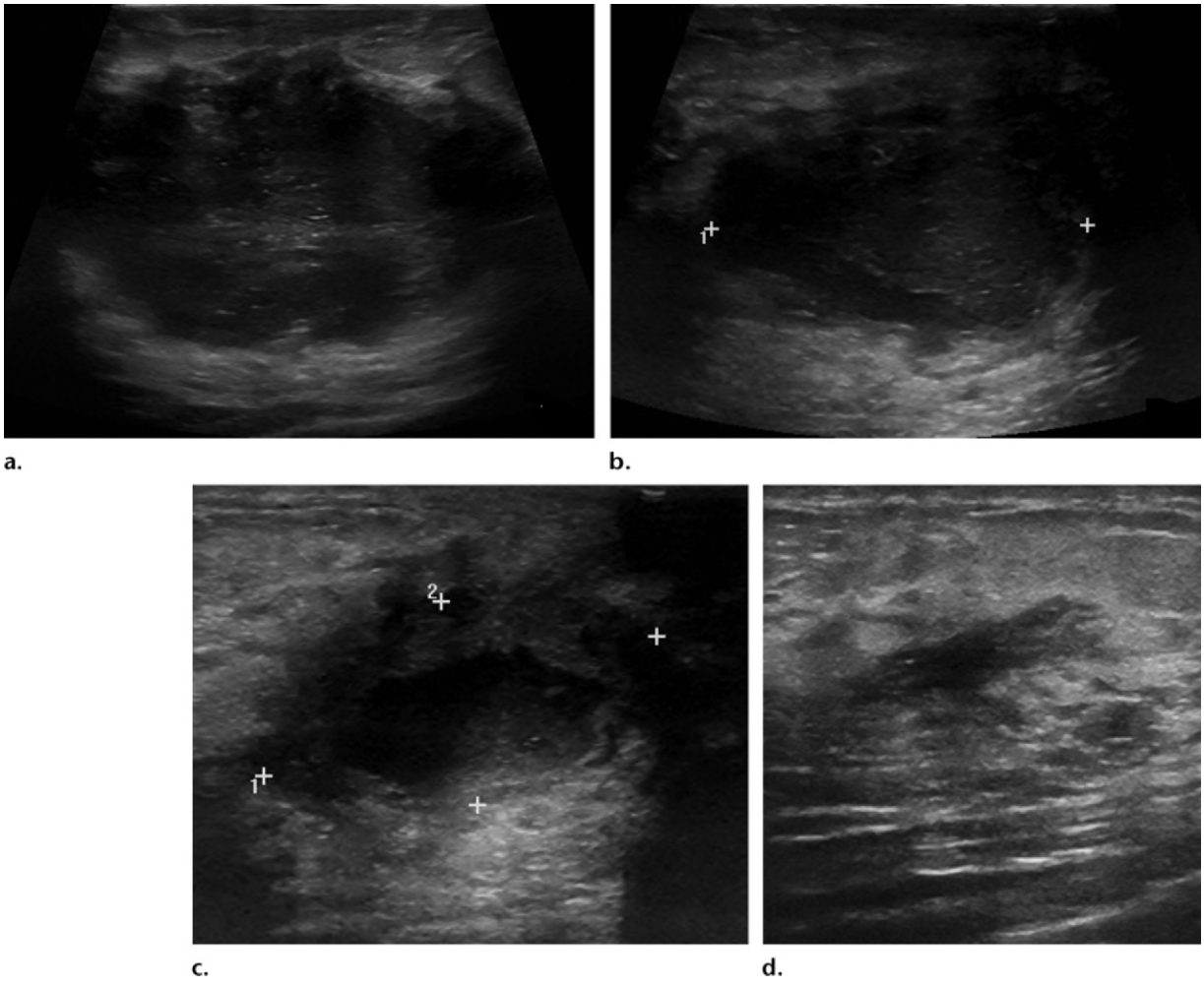


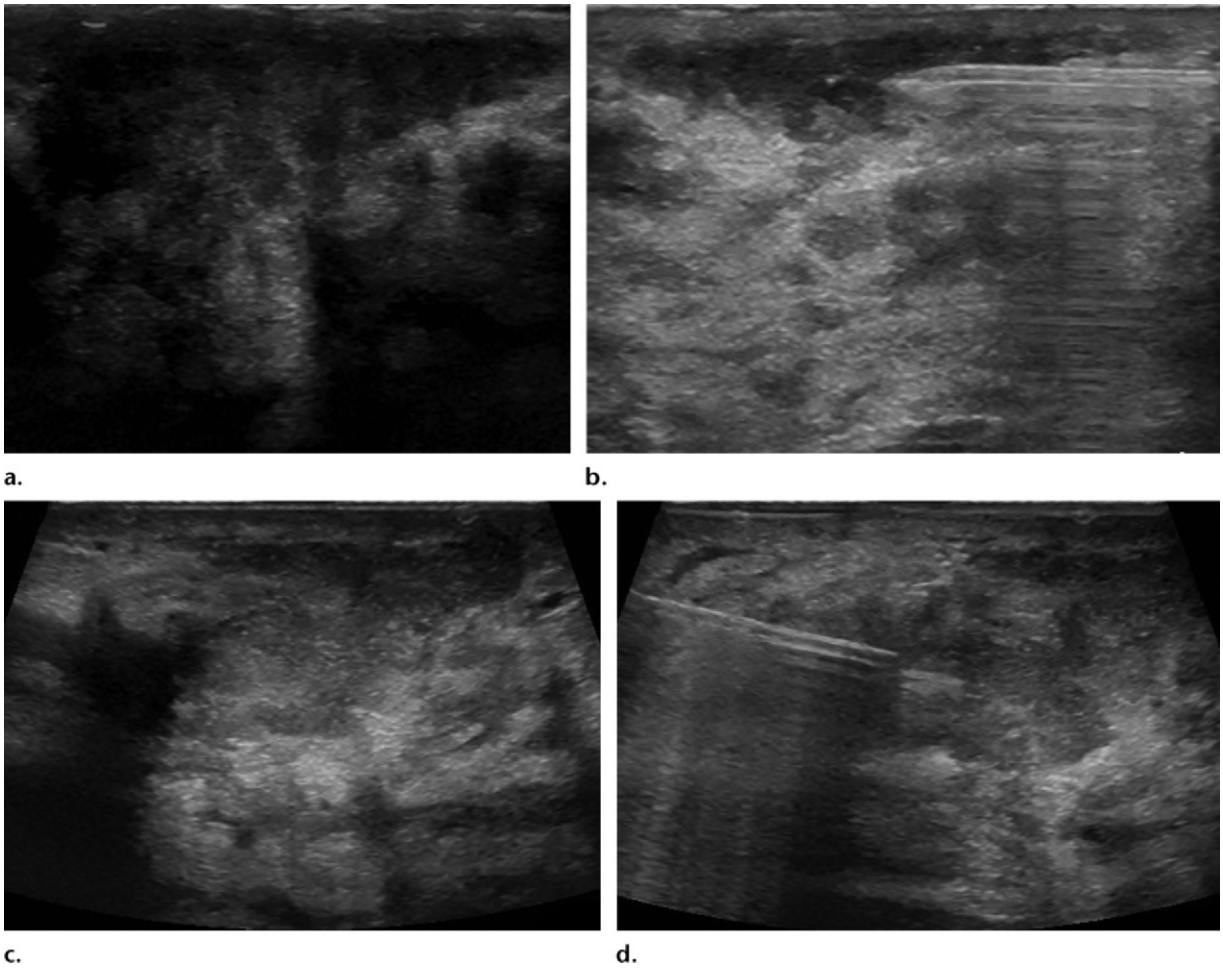
Figure 2. Central nonpuerperal abscess in a 17-year-old smoker with nipple retraction and a palpable central mass in the right breast. There were no associated inflammatory signs. **(a)** US image shows a heterogeneous 37-mL collection with posterior enhancement. Percutaneous drainage with an 18-gauge needle yielded 35 mL of purulent material, which was sent for culture. The patient was prescribed clindamycin empirically for 10 days and instructed to return for evaluation in 1 week. **(b)** US image obtained 1 week later shows a smaller 18-mL cavity, which represents slight improvement. However, there are more internal echoes, a finding suggestive of thick material. Repeat aspiration was performed and yielded 15 mL of fluid. Cultures from the first culture series showed growth of *Staphylococcus* that was resistant to clindamycin. The patient was prescribed a course of cloxacillin and instructed to return 1 week later. **(c)** US image obtained 1 week later shows a 5-mL residual collection, which represents significant improvement. Repeat aspiration yielded 4 mL of pus, and continued antibiotics were prescribed. At evaluation 3 weeks later, clinical symptoms had disappeared. **(d)** US image obtained 3 weeks later shows a residual irregular hypoechoic zone. Because of the unusual clinical presentation, core biopsy was performed. Pathologic analysis demonstrated marked chronic inflammation without any signs of atypia or neoplasia. The further clinical course was favorable.



It is thought that these abscesses form as a complication of periductal mastitis. Squamous metaplasia of the cuboidal epithelium is a first step and leads to formation of keratin plugs, central acute inflammatory infiltrates, and cellular debris, which distend and obstruct the lactiferous ducts, leading to duct dilatation. Secondary infection ensues with stagnation, leading to abscess formation and development of cutaneous fistulas that involve the periareolar region and form as a means to release pressure from pus distending the ducts (11–13).

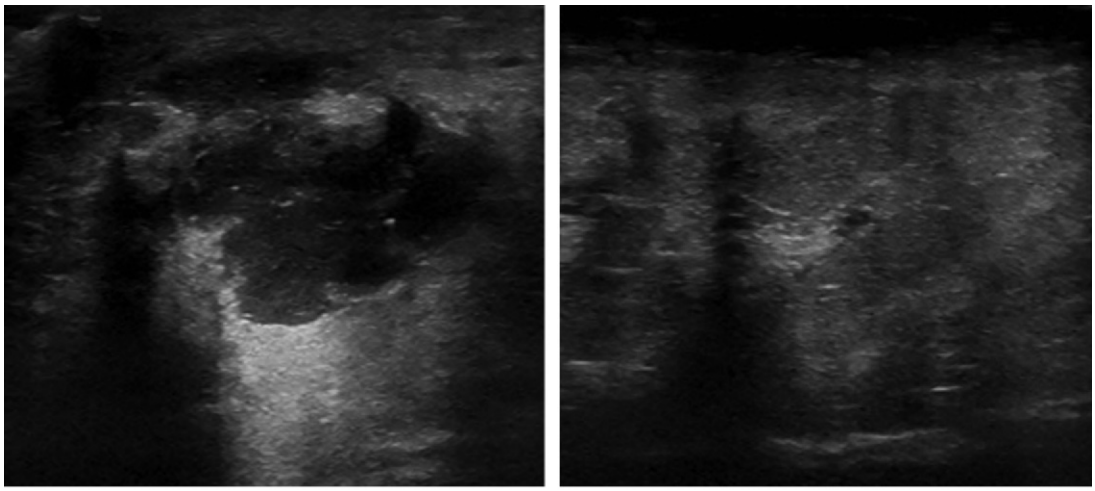
It is speculated that smoking may have a direct toxic effect on the epithelium of retroareolar

Figure 3. Bilateral recurring periareolar abscesses in a 25-year-old woman who noted an area of redness and swelling in the right breast with spontaneous pus drainage from a fistulous tract 1 day earlier. There was no associated fever. A 500-mg dose of cephalexin twice a day was prescribed for 10 days. **(a)** US image shows a hypoechoic irregular collection in the periareolar region. Although the sonographic appearance was suggestive of thick fluid, aspiration was attempted. **(b)** US image shows aspiration with an 18-gauge needle, which yielded 4 mL of thick, slightly bloody material that was sent for culture. The collection decreased in size. No microorganisms were identified in the cultures. Three months later, because of continued symptoms, the patient consulted a surgeon and an incision and drainage procedure were performed. One year later, the patient experienced a new infectious episode, which this time affected the left periareolar region. Cloxacillin was initially prescribed; radiologic evaluation was peformed 4 weeks later because symptoms persisted. **(c)** US image shows an ill-defined multiloculated collection. **(d)** US image shows drainage with an 18-gauge catheter. Less than 2 mL of material was obtained; again, cultures sent for microbiologic analysis were sterile. A repeat course of an antibiotic (clindamycin) was nonetheless prescribed for 10 days, with the thought that the cultures may have been falsely negative due to previous antibiotic treatment. Because of a new fistula tract that occurred 4 weeks later, the patient underwent surgical incision and drainage in the operating room to treat the recurrent left breast abscess.



ducts (11). Bilateral abscess formation is seen in as many as 25% of these patients (14). The term *Zuska disease* was coined to describe the clinical condition of recurring central nonpuerperal abscesses associated with lactiferous fistulas (14–16) (Fig 3).

Central nonpuerperal abscesses are the most difficult to treat, with a chronic clinical course. Recurrences occur in 25%–40% of women, with formation of cutaneous fistulas in one-third of women (1,4,13). Microbiologic analysis often reveals mixed flora (*Staphylococcus* and *Streptococcus*) with a greater risk of anaerobes (9) (Fig 4).



a. b.

Figure 4. Central nonpuerperal abscess in a 36-year-old woman with periareolar redness and a palpable painful mass in the right breast at the 1-o'clock position. The patient was a smoker who had undergone surgery twice before for recurrent left breast subareolar abscesses. The patient's mother had been diagnosed with breast cancer at 49 years of age. **(a)** US image shows an ill-defined heterogeneous collection, from which 5 mL of thick greenish purulent material was drained under US guidance. Cultures showed growth of mixed anaerobes, predominantly *Bacteroides* and *Fusobacterium*. The patient was treated with clindamycin for 10 days. **(b)** Follow-up US image obtained 1 month later shows complete resolution of the collection.

Treatment is by means of percutaneous drainage and antibiotics. These young patients should also be strongly encouraged to stop smoking, as this is the most significant factor associated with recurrence (4). In addition, diagnostic mammography is recommended in women older than 35 years to rule out malignancy.

Teaching Point

Peripheral Nonpuerperal Abscess.—Peripheral nonpuerperal abscesses are less common and occur at a slightly older age than central nonpuerperal abscesses and puerperal abscesses (Fig 5). They can occur in women with underlying chronic medical conditions, such as diabetes and rheumatoid arthritis. Peripheral nonpuerperal abscesses can also be encountered in women taking steroids or with recent breast interventions, such as those in the postoperative or post–radiation therapy period, although most have no associated medical conditions (1).

As with other forms of abscesses, the most common pathogen is *Staphylococcus aureus*, but *Streptococcus* and anaerobic flora can also be encountered (Fig 6). This form of abscess responds well to drainage and antibiotics. Recurrences are generally rare.

The proportions of these abscess subtypes encountered will vary from one practice to the next. In the literature, reported ranges are 14%–59% for puerperal abscesses and 41%–86% for nonpuerperal abscesses (2,4,17). Among all abscesses, 34%–94% involve the retroareolar region (2,11,17).

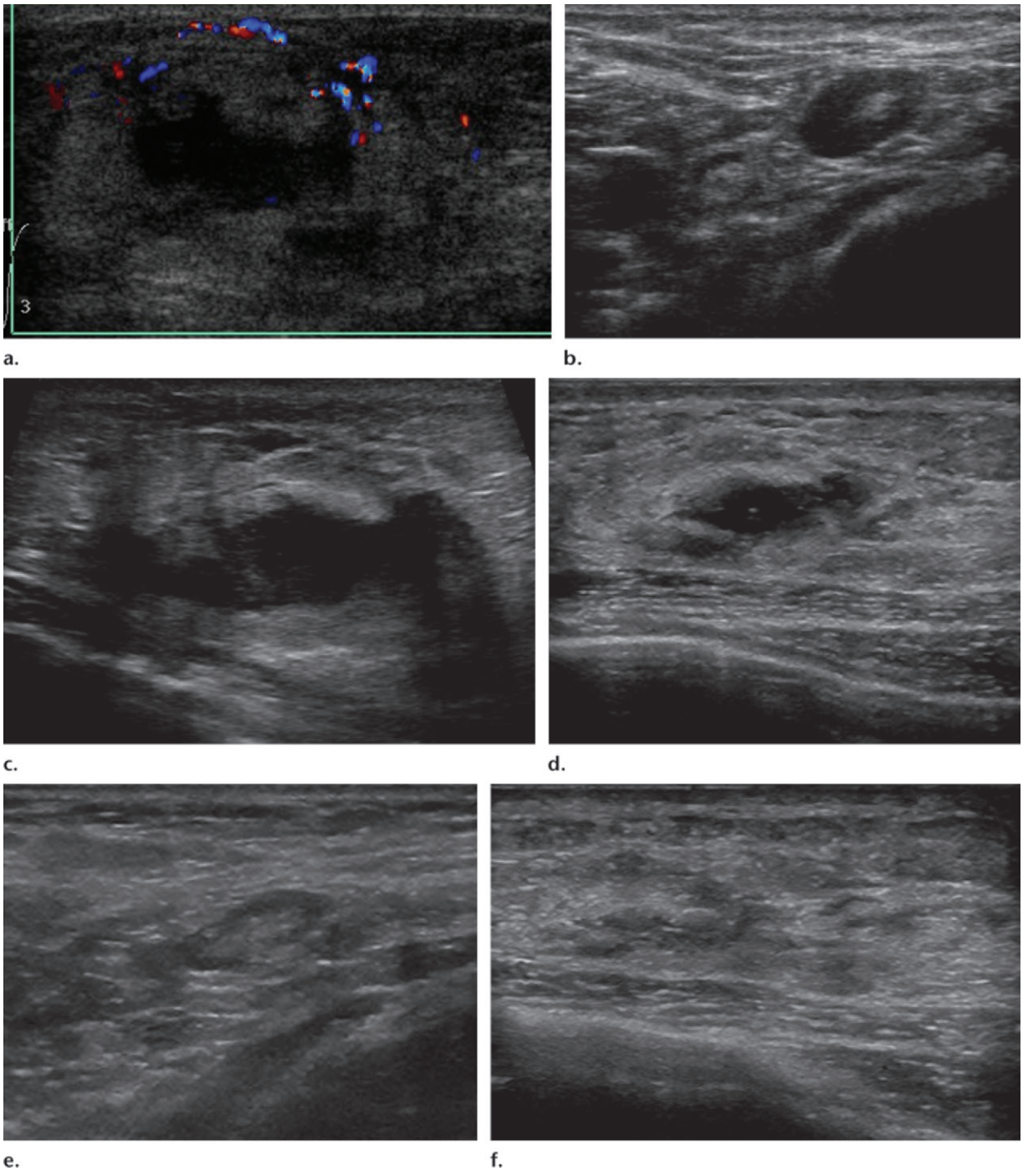


Figure 5. Peripheral nonpuerperal abscess in a 37-year-old woman with a painful, progressive, palpable mass in the upper inner quadrant of the left breast. No skin redness or other signs of infection were found. Clinically, the treating physician suspected a cyst and referred the patient to an outside clinic for US evaluation. **(a)** Color Doppler image shows an ill-defined heterogeneous lesion with increased vascularity in the periphery and a small hypoechoic center. The lesion was interpreted as suspicious for malignancy. **(b)** US image of the ipsilateral axilla shows an enlarged lymph node, which was interpreted as suspicious for malignancy because of the breast mass. The patient was referred to our center for further evaluation; repeat US and mammography were performed. **(c)** On a US image, the lesion appears enlarged and more clearly liquid in the center. The possibility of an infectious lesion was considered. US-guided drainage yielded 4 mL of yellowish thick purulent material. Fine-needle aspiration of the cortex of the enlarged lymph node was also performed but revealed only inflammatory changes. The patient was prescribed cloxacillin for 7 days and instructed to return 2 weeks later. **(d)** Follow-up US image obtained 3 weeks later shows decreased size of the collection. Repeat aspiration yielded less than 1 mL of thick material. A second course of antibiotics was prescribed after cultures showed growth of clindamycin-sensitive *S aureus*. **(e)** US image shows that the lymph node has already regained its normal cortical thickness, despite the presence of a residual small breast collection. **(f)** US image obtained 1 month later shows near-complete resolution of the signs of infection, with only a mild area of decreased echotexture in the region where the abscess had been.

Figure 6. Peripheral nonpuerperal abscess in a 22-year-old woman with a palpable progressive mass in the upper outer quadrant of the right breast. There was no associated redness or pain. The patient was a smoker, had undergone bilateral nipple piercing 3 months earlier, and was the mother of a 2-year-old child. **(a)** Initial US image shows a large (65-mL), heterogeneous, mostly hypoechoic, irregular lesion. The possibilities of a complex cyst or galactocele were considered. Because of the heterogeneous texture, the radiologist thought that a solid component could not be ruled out with US alone and that aspiration was required. US-guided aspiration was performed with a 14-gauge needle. A total of 10 mL of pus was retrieved, after which lavage of the residual collection was performed three times with normal saline. The patient was prescribed cloxacillin for 10 days. Follow-up US was performed 6 days later because of lack of clinical improvement. Cultures showed growth of *Streptococcus* and mixed anaerobes, mostly *Fusobacterium* and *Peptostreptococcus*. Clindamycin was prescribed. **(b)** US image shows that the collection has reaccumulated since the first aspiration attempt. Repeat aspiration was attempted and yielded 15 mL of brownish thick material. The patient was instructed to return in 4 days for reevaluation. **(c)** US image obtained 4 days later shows that the collection has further increased in size. A decision was made to insert a drain. An 8-F catheter from Cook (Bloomington, Ind) allowed immediate drainage of 60 mL of thick material. Clinical follow-up revealed decreased drainage from the catheter after a few days. **(d)** Repeat US image shows a slightly smaller abscess with numerous internal echoes. A decision was made to remove the catheter 6 days after insertion. Antibiotic therapy was continued. The clinical course required surgical incision and drainage, with placement of a mesh that remained in place for 3 weeks. **(e)** Follow-up US image obtained 2 months later shows a small residual area of hypoechoic texture, which represents significant improvement. This area eventually resolved fully.

Abscesses can also develop as a secondary infection of a cutaneous lesion (eg, sebaceous cyst or hidradenitis suppurativa). Such abscesses are usually easily diagnosed because of the presence of a skin lesion.

Imaging Evaluation of Breast Abscesses

Common clinical symptoms of breast infection include pain, redness, and heat, while fever is infrequently encountered. It may be difficult for the clinician to differentiate an abscess from mastitis, especially if the collection is small or situated deep in the breast. When there is clinical suspicion of an abscess, for example in the setting of a palpable mass or a localized area of tenderness, the woman should be referred for US evaluation.

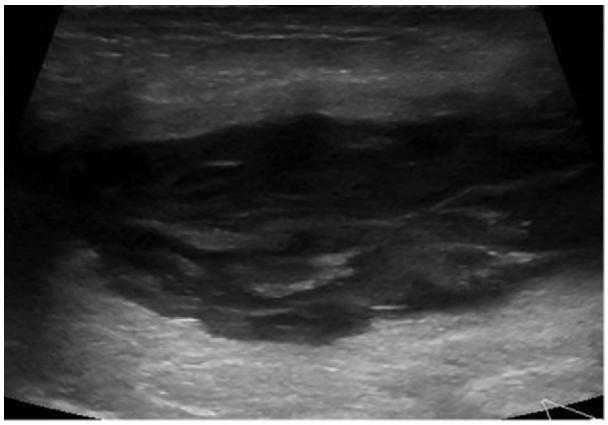
In a study of 73 breast abscesses that manifested as a palpable mass, Leborgne and Leborgne (2) reported that 80% of the masses were painful and 71% were associated with overlying skin redness; fever was documented in only 12% of women. Other authors confirm these findings, with fever present at diagnosis in 5%–47% of patients (18,19). In women who underwent US to verify the presence of an abscess, a collection was confirmed in 40%–65% of cases (5,17), with more than one collection in 21% (5). Rarely, breast abscesses manifest without a preceding clinical episode of mastitis.

At US, mastitis appears as an ill-defined area of altered echotexture with increased echogenicity in the infiltrated and inflamed fat lobules, hypoechoic areas in the glandular parenchyma, and associated mild skin thickening with occasional distended lymphatic vessels (5). Inflammatory axillary lymph nodes may also be encountered and demonstrate mild to moderate circumferential cortical thickening and increased flow at Doppler US. The diagnosis of abscess requires identification of a hypoechoic collection of variable shape and size, multiloculated in most cases (7), often with a thick echogenic periphery where increased vascular flow is identified. There should be no vascularity in the collection, and acoustic enhancement is present due to fluid content.

US is the first-line investigation because it is relatively painless, allows regular breast evaluations during the course of therapy, and provides guidance for percutaneous drainage. A high-frequency linear probe (7.5–14 MHz) is used, with color Doppler imaging routinely added to the evaluation. To facilitate follow-up, the volume of the abscess can be calculated with the following formula for ellipsoid structures: $D_1 \times D_2 \times D_3 \times 0.52$, where D is the diameter of the collection. The diameters of the three axes are measured in centimeters, and the result is a volume in milliliters (3).

Mammography is recommended to exclude malignancy in women presenting outside the peripartum period, but some authors recommend it in all women older than 30 years (20,21). Mammography should also be considered in breast-feeding women when the clinical course is prolonged. Whenever possible, it is suggested that mammography be delayed until after the acute episode because of patient comfort and examination performance considerations: the increased radiopacity associated with the inflamed breast and the lower breast compression that the woman can tolerate can mask an underlying lesion.

Mammography can show skin thickening, an asymmetric density, a mass, or distortion; these signs are not specific for carcinoma and may reflect only the underlying infection and breast abscess. On the other hand, the presence of sus-



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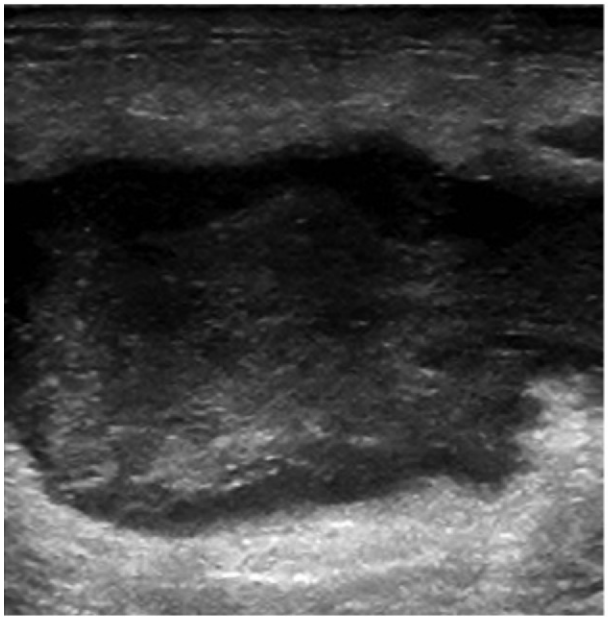

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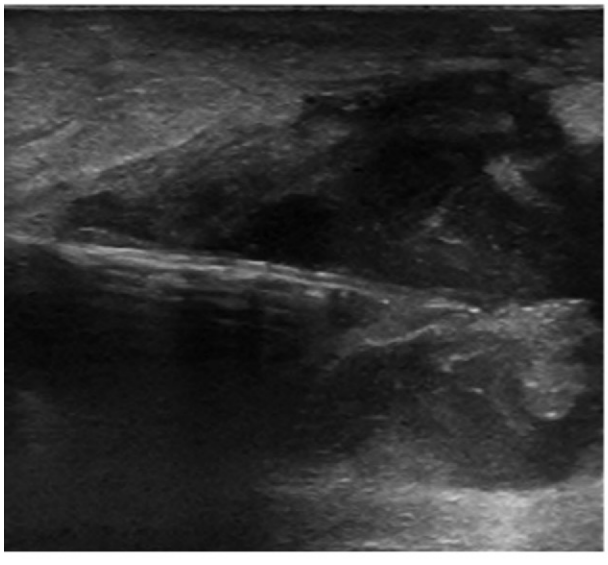

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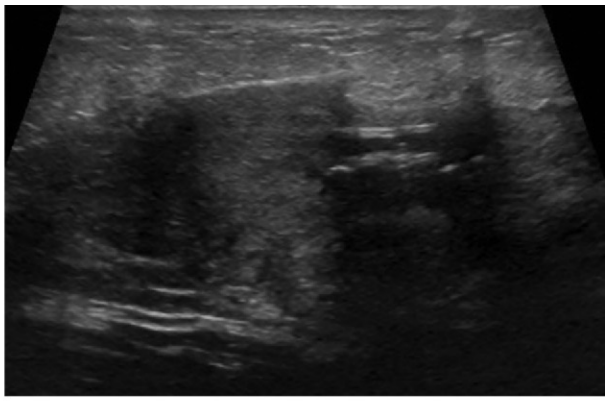

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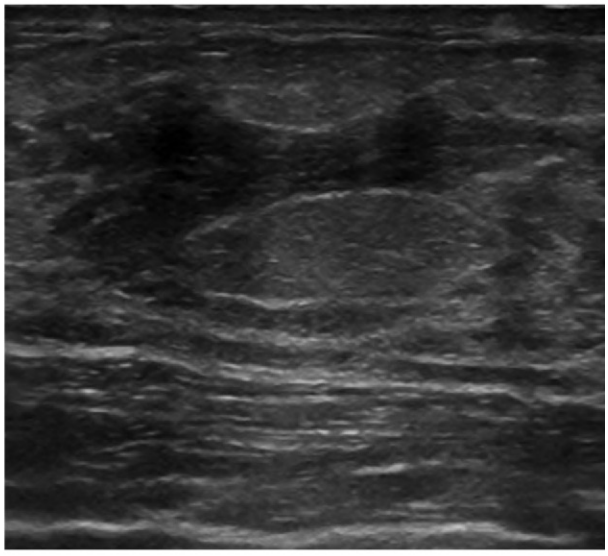


e.

picious microcalcifications is a more specific sign and should lead to a biopsy to rule out carcinoma (22,23). The difference between breast abscess and inflammatory carcinoma is further discussed in the section on inflammatory carcinoma.

Magnetic resonance (MR) imaging is not generally indicated and can be reserved for atypical situations.

Antibiotic Coverage

Treatment with antibiotics should always be offered in addition to percutaneous drainage. Good first-line antibiotic options include 500 mg of cloxacillin administered orally four times daily for 7–10 days. Alternatives are 300 mg of clindamycin administered four times daily, 500 mg of erythromycin administered three times daily, or 500 mg of cefazolin administered four times daily. Some authors suggest adding 500 mg of metronidazole administered three times daily from the onset in the treatment of nonpuerperal abscesses (11,17).

After aspiration, the material obtained should always be sent for microbiologic analysis, where the pathogen can be identified and its antibiotic

sensitivity profile determined to allow subsequent antibiotic adjustment, if necessary. When the clinical scenario suggests a greater risk of recurrence, for example when dealing with nonpuerperal central abscesses, broader-spectrum antibiotics can be prescribed from the onset.

US-guided Intervention

Up until the early 1990s, surgical incision and drainage was the recommended treatment for breast abscesses. It was generally performed with the patient under general anesthesia, with the added procedure of excision of lactiferous ducts (microdochectomy) occasionally performed at the same time (24). Complications associated with these surgical interventions were not rare, with cutaneous fistulas developing in 5%–12% of patients and abscess recurrences in 10%–38% of cases (3,25).

Teaching Point

In the past 15 years, US-guided intervention has become the preferred approach. It can be performed rapidly, with local anesthesia, in ambulatory patients, with minimal to no scarring, without the need to interrupt breast-feeding, and with a complication rate similar to or lower than that of surgical incision and drainage (3,8,17,25).

Evidence-based Management of Breast Abscesses

US-guided Drainage: Technical Protocol

We performed a Medline search to identify all relevant studies on management of breast abscesses. Twenty studies that provided information about patient population, drainage technique, and subsequent follow-up were retained for analysis (2–5,7,8,10,11,13,17,18,20,21,25–31). They report on a total of 975 patients, with a range of 10–151 patients in each study; cases were managed with different techniques and in different clinical contexts.

Overall, there are no good studies available to answer the question of how best to manage breast abscesses. Published studies involve small numbers of patients, there are no control groups in the descriptive studies available, and there are no strong randomized trials in the literature, to our knowledge (32). With these limitations in mind, we strove to synthesize the available literature to propose an evidence-based algorithm for diagnosis, management, and follow-up of breast abscesses.

The reviewed studies report an overall success rate for percutaneous drainage of 54%–100%. Variations in performance depend in part on the clinical context of the abscess (puerperal vs nonpuerperal), the size of the abscess, and the definition used for success. Some studies did not include multiple aspirations, with treatment considered a failure if a single aspiration attempt had failed. However, repeat treatments are often necessary for complete resolution of symptoms.

Studies also varied in terms of the technique used: Some performed drainage with US guidance, but not all. Some used saline irrigation, but most did not. The needle size for aspiration varied from 25 gauge to 14 gauge. Some used an indwelling catheter. As far as antibiotics, they were administered orally in most studies and intralesionally in others; other studies did not consider systematic treatment of all patients.

Overall, disease control is best achieved with US guidance (as opposed to guidance with palpation) and with repeat aspirations performed as necessary until complete resolution. Best results are achieved in abscesses that measure less than 3 cm, although a trial of US-guided drainage is recommended for abscesses of all sizes—those that manifest in the breast-feeding period, those with *S aureus* as the etiologic agent, and those without a multiloculated structure. On the other hand, nonpuerperal periareolar lesions are the most difficult to treat, as are those with mixed or anaerobic flora (4). Recurrence is more common in smokers, obese women, and blacks (4).

From careful reading of the literature and multidisciplinary discussions with our breast team (breast specialists and surgeons in association with radiologists), the following key factors in the management of breast abscesses emerged.

What Needle Should Be Used for Drainage?—Needle size for aspiration varied from 25 gauge to 14 gauge. Because the infected fluid in abscesses is often quite viscous, an 18-gauge needle appears to be a good choice, allowing adequate aspiration in most cases. In case of thicker and viscous material, a 14-gauge needle may be necessary.

Local anesthesia is used for all procedures. Despite use of a local injection, the procedure remains painful in a fraction of women owing to extensive local inflammation. Application of an ice pack above the abscess before drainage can be an alternative: word of mouth is that this nonmedicinal technique is effective in lowering the pain associated with the drainage procedure (personal communication, November 28, 2010). Application of an anesthetic cream (EMLA; AstraZeneca Canada, Mississauga, Ontario) before the procedure is another option.

When Should an Indwelling Catheter Be Used?—Karstrup et al (33) proposed percutaneous drainage of abscesses with US guidance in 1990, and

early studies that evaluated the performance of this technique tested use of indwelling catheters for all abscesses. Later, indwelling catheters were reserved for treatment of larger collections; many authors used this approach for abscesses larger than 3 cm (5,17,20), an arbitrarily determined size cutoff. Mean catheter times within the breast were 4–6.4 days (range, 1–25 days) for puerperal abscesses, with a longer mean catheter time for abscesses larger than 3 cm (5,7).

Christensen et al (17) did not observe any effect of size or location of the abscess on the recovery rate. Ulitzsch et al (5) reported recurrences on catheter removal in 15% of cases; in most cases, the recurrences were treated with needle drainage without a need for catheter reinsertion. Catheter placement was well tolerated, with a mean pain score of 2.3 (on a subjective pain scale of 0–10) in 22 women (5). Cosmetic results were satisfactory, leaving no conspicuous scars. When the patient so desired, breast-feeding could be maintained throughout treatment in most cases.

How Many Aspirations Should Be Attempted before Modifying Treatment?—More recent studies tested the possibility of treating breast abscesses with repeat percutaneous drainage, without placing an indwelling catheter (2,3,18,28). Even in cases of puerperal abscesses, Ulitzsch et al (5) reported repeat needle aspirations in 12 of 23 abscesses that measured less than 3 cm at diagnosis (52%), with a mean number of aspirations of 1.8 per abscess (range, one to five) and a final 100% success rate. Christensen et al (17) reported a 97% success rate (86 of 89 cases) in treating puerperal abscesses with a single US-guided aspiration procedure, with a lower 81% success rate (50 of 62 cases) for nonpuerperal abscesses. The mean number of follow-up examinations in the ultrasound department was four (range, one to 10) for women with puerperal abscesses and three (range, one to seven) for women with nonpuerperal abscesses.

Elagili et al (18) treated 31 abscesses, 47% of which were puerperal, with US-guided aspiration and obtained complete resolution in 50% of the collections after one aspiration, in an additional 23% after two aspirations, and in an additional 10% after three aspirations, with a final 83% success rate for aspiration without resorting to surgical drainage. In a study of patients who mostly (86%) had nonpuerperal abscesses, Imperiale et al (3) reported a median of two aspirations (range, one to five) for collections less than 3 cm and a median of 3.5 aspirations (range, one to seven) for those larger than 3 cm, with a 96% success rate. Hook and Ikeda (28) reported a 100% success rate when treating collections smaller than 2.4 cm with a single US-guided aspiration; 10 of these 13 cases (77%) were nonpuerperal.

After careful review of published data and numerous discussions with surgeons and breast specialists, our recommendation is that indwelling catheters be avoided as much as possible because the success rate of repeated drainage is as good as that of catheter drainage, because of the risk of cutaneous fistulas, and for reasons of patient comfort. Overall, catheter drainage is generally not required and seldom used in our practice. In complicated clinical situations, we will consider catheter placement in cases of recurring abscesses after more than five aspirations. In those instances, a catheter size of 6 F to 8 F is adequate.

Should Saline Lavage of the Abscess Cavity Be Performed?—Saline lavage is recommended by most authors for US-guided treatment of all abscesses (2,7), especially when dealing with larger collections. It can be performed by inserting a 2.0-mm plastic cannula into the collection or using a 10-mL syringe and flushing two or three times with normal sterile saline until the aspirate returns clear.

Should Antibiotics Be Instilled Directly into the Cavity?—Oral antibiotics are generally sufficient, although a few authors recommend additional intralesion injection (2,3). Leborgne and Leborgne (2) injected 1 g of cephradine—a first-generation cephalosporin—into abscess cavities measuring more than 25 mm in diameter, with simultaneous administration of oral antibiotics. They successfully treated 27 of 29 abscesses (93%) in this manner.

Imperiale et al (3) administered 40–160 mg of gentamicin into the abscess cavities in 26 patients who presented in a nonpuerperal setting and in whom an initial course of systemic antibiotics had failed. They reported a 96% success rate with this treatment approach, with only one woman requiring surgical drainage. No systemic antibiotics were administered in this study.

These two studies showed that administration of additional local antibiotics directly into the abscess cavity of larger lesions is associated with excellent success rates, comparable to those obtained with percutaneous drainage of smaller abscesses. This fact suggests a benefit to local antibiotics, but the level of scientific evidence available in the literature remains weak. Leborgne and Leborgne (2) cautiously conclude that "local instillation of antibiotics is probably beneficial."

When Is Surgery Indicated?—A small minority of women will ultimately be referred for surgical treatment. The more recent articles describing the treatment of breast abscesses suggest referring women for surgical drainage after failure of several attempts (at least three to five) at US-guided drainage, although management decisions depend on the clinical context (13). Multiloculated and larger abscesses (the most common size cutoff is 3 cm) are more difficult to treat and associated with an approximately 50% rate of failure to cure with aspiration (18,31).

Late presentation was also significantly associated with failure of percutaneous drainage in a series of 33 abscesses, with a 100% success rate reported in women treated within 6 days of symptom onset (31). However, this finding may be confounded by the fact that later presentation is associated with larger abscesses. Indeed, the largest single study published, which evaluated 151 abscesses treated with US-guided drainage, did not report any effect of time from symptom onset to treatment on overall resolution time (17).

Surgeons in our practice expect radiologists to treat the acute episode with percutaneous drainage and antibiotics. For recurrent central nonpuerperal abscesses, surgical resection of the inflamed retroareolar ducts—a procedure termed *microdochectomy* (24,28)—can be attempted, preferably after the acute episode has resolved. In a personal review of 67 recurring subareolar nonpuerperal abscesses, Lannin (13) observed that medical management is successful in approximately 50% of patients, with the other one-half requiring definitive duct excision for symptom control. However, surgical resection of the inflamed ducts is not curative, with a recurrence rate of 28% (11 of 39 cases) for nonpuerperal central abscesses (11), a nonnegligible fraction of women. Nevertheless, this recurrence rate is significantly lower than that in cases managed without surgical excision, which is reported to be 79% (128 of 163 cases).

Recommendations for Follow-up

For puerperal abscesses, because of a good clinical course in most patients and recurrences in a minority of patients (1,4), clinical follow-up is usually sufficient after US-guided drainage. US may be repeated if the clinical response is incomplete after treatment, and mammography should be considered if there is a prolonged clinical course.

Nonpuerperal abscesses also require clinical follow-up. If there is a good clinical response, a single US follow-up at 14 days can be considered to verify complete resolution of the collection.

In cases of a partial clinical response, which in our clinical experience occurs in most patients, repeat US evaluations are recommended until complete resolution. We routinely perform these follow-up evaluations every 7–14 days, with more frequent evaluations performed early in the course of follow-up. This interval may need to be adjusted according to clinical practice: Our clinicians reevaluate patients after completion of a course of antibiotics, therefore generally every 7–14 days. Obviously, this interval may be shortened if clinical symptoms justify it. Median follow-up times will vary depending on the clinical context but can usually be measured in weeks (8).

Infections of the Male Breast

Infectious complications also occur in men, although they are very rare: only six of the 975 abscess episodes described in the 20 studies reviewed (2–5,7,8,10,11,13,17,18,20,21,25–31) occurred in men. Most episodes in men involve the periareolar region (20,34) (Fig 7). Infection with human immunodeficiency virus may be a risk factor (reported in one patient) (20,26).

Treatment strategies are the same as for women, including follow-up until complete resolution, with repeated aspirations as necessary. In this patient population, as for women, diagnostic mammography is suggested after treatment of the acute episode to rule out breast carcinoma. A chronic recurrent clinical course is not uncommon, occasionally leading to formation of periareolar fistulas (34).

Noninfectious Mimics

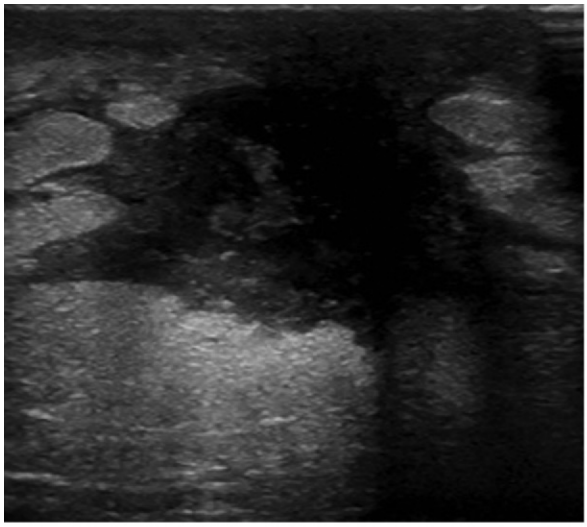
Inflammatory Carcinoma

Among the 975 patients reported in the 20 studies reviewed (2–5,7,8,10,11,13,17,18,20,21,25–31), six cases of inflammatory carcinoma were encountered (0.6%). One was diagnosed because of suspicious microcalcifications at mammography; two were diagnosed by means of a breast biopsy performed because of a chronic clinical course and absence of a response to antibiotics and drainage. (Information for the other three patients with carcinoma was not available.)

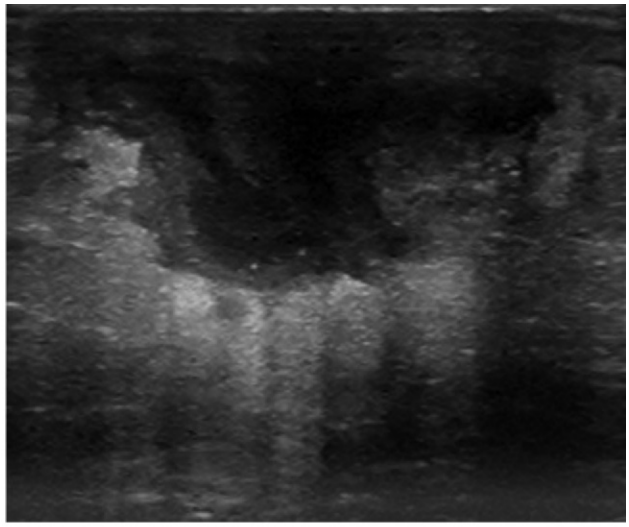
Teaching Point

When a patient presents with erythema and swelling but no abscess is identified at US, inflammatory carcinoma should be considered, particularly in older and nonlactating women. Some physicians suggest an initial trial of antibiotics. Nevertheless, additional investigations including mammography and biopsy should be promptly performed to differentiate between infection and malignancy, depending on the clinical context (nonpuerperal setting, family history of breast cancer) (22).

Figure 7. Male breast infection in a 56-year-old man with a palpable left breast mass centered on the nipple. **(a)** US image shows an ill-defined heterogeneous collection associated with skin thickening. There is posterior enhancement. Local anesthesia was administered to proceed to a breast biopsy, but the lesion was found to be soft, with mobile echoes. Therefore, aspiration was attempted with an 18-gauge needle, and 5 mL of whitish thick fluid stranded with some blood was retrieved and sent for cultures. Cloxacillin therapy was begun. Follow-up was performed 2 weeks later. Clinical improvement was noted, but there was a residual palpable abnormality. Cultures showed growth of *Staphylococcus*. **(b)** Repeat US image shows a smaller abscess. Repeat aspiration was performed and yielded less than 0.5 mL of thick fluid. Antibiotic therapy was changed to vancomycin. Six weeks later, the patient was again referred to the US suite because of clinical deterioration. **(c)** US image shows that the abscess has reaccumulated, with a thick inflammatory periphery. Four milliliters of pus could be retrieved. After surgical consultation, the patient opted for definitive treatment and a mastectomy was performed. No malignancy was seen.



a.



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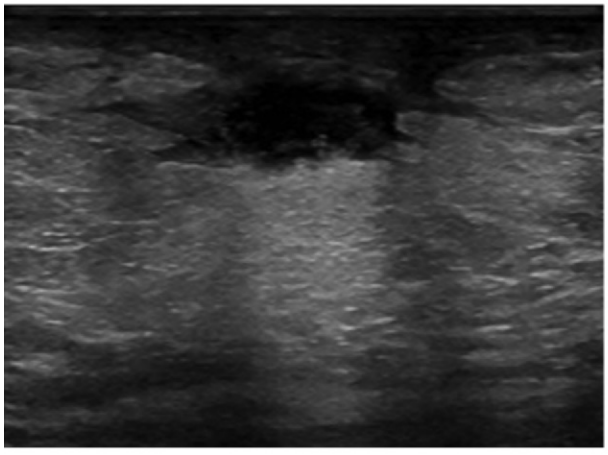

b.

Although mammography is painful in women with infectious mastitis, our experience is that inflammatory carcinoma is generally less painful and mammography can be tolerated so that image quality is not too compromised. The signs of inflammatory carcinoma at mammography are not specific. Skin and trabecular thickening from breast edema may be encountered. It has been reported that the skin thickening that occurs in breast infections is generally more localized than that found in inflammatory carcinoma. Mammography may also reveal a focal or more diffuse asymmetric density, distortion, an irregular mass, or suspicious microcalcifications (22).

A study that compared 48 cases of inflammatory carcinoma with 42 cases of acute mastitis (35) showed a similar prevalence of suspicious microcalcifactions in both groups (19% vs 5%, respectively). However, the prevalence of microcalcifications reported in other studies of women with inflammatory carcinoma is much greater, averaging 47% (147 of 311 cases from pooled different studies) (23,36–39). Therefore, Chow (23) states that malignant microcalcifications, when visible, are the most specific sign of an underlying tumor.

In addition, the comparative study of inflammatory carcinoma and mastitis (35) reported that masses were more often seen in cases of carcinoma at mammography (67% vs 36% in cases of mastitis) and at US (75% vs 45% in cases of mastitis). However, this study evaluated women with infectious mastitis, whether or not an abscess was present. Nevertheless, in an analysis of mammographic findings in women with abscesses, Crowe et al (19) obtained similar results, with 32% of abscesses (six of 19) appearing as an irregular mass at mammography.

In addition to identification of a mass, the diagnosis of inflammatory carcinoma may be suspected at US on identification of enlarged lymph nodes, which are reported in 56%–73%

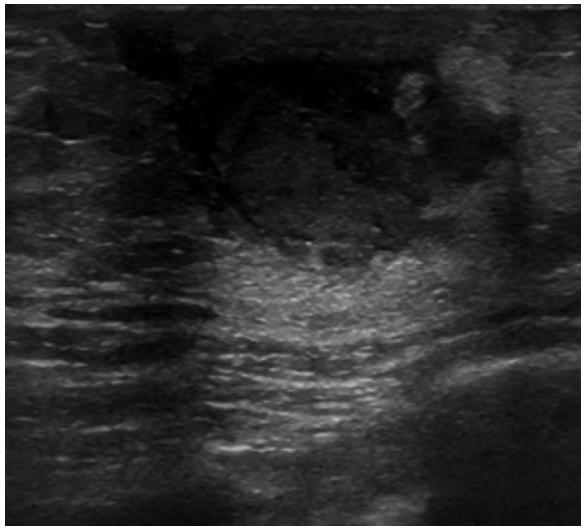

Figure 8. Chronic granulomatous mastitis in a 53-year-old man who was treated with antibiotics for a presumed central abscess, with no clinical improvement. US image shows an irregular, heterogeneous, hypoechoic central lesion. Power Doppler US showed hypervascularity in the periphery of the lesion, a finding interpreted as indicative of inflammation. Aspiration was attempted but did not yield any fluid. Biopsy was performed with a 14-gauge core needle; the diagnosis of chronic granulomatous inflammation was confirmed at pathologic analysis.

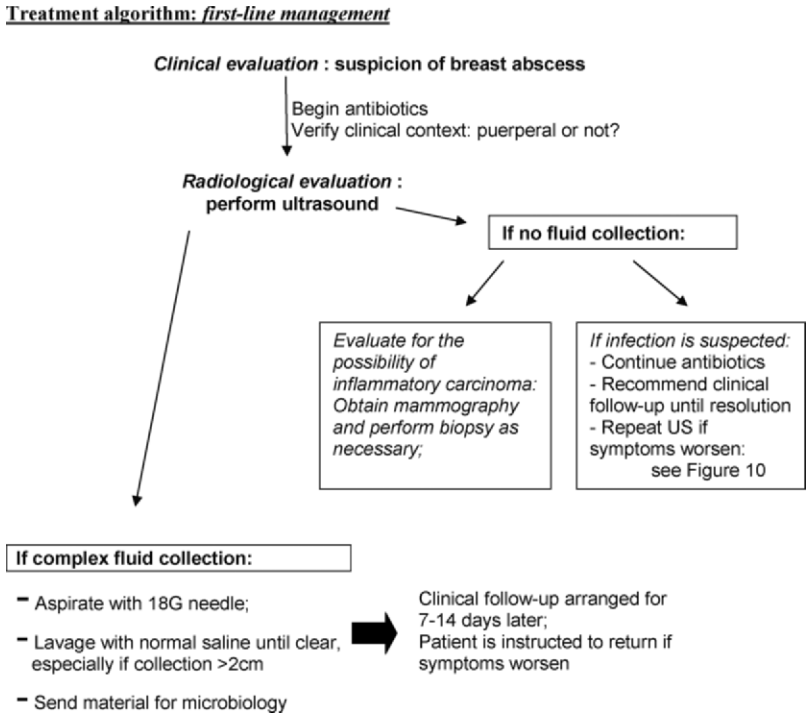

Figure 9. Proposed algorithm for first-line management of a suspected breast abscess. *G* = gauge.

of women with inflammatory carcinoma (23,38–40). In women with breast abscesses, diffuse mild cortical thickening may be encountered at US in the axillary lymph nodes. Conversely, enlarged lymph nodes in women with inflammatory carcinoma characteristically display more marked cortical thickening and hilar displacement, findings typical of metastatic nodes (19,36,40,41).

Finally, MR imaging may also be of utility in differentiating inflammatory carcinoma from breast abscess. In a study of 90 women, masses tended to be smaller, were more often retroareolar, and had higher T2 signal intensity in women with infections. Conversely, carcinoma was associated with more rapid and marked enhancement, washout kinetics, and signs of pectoralis invasion (35).

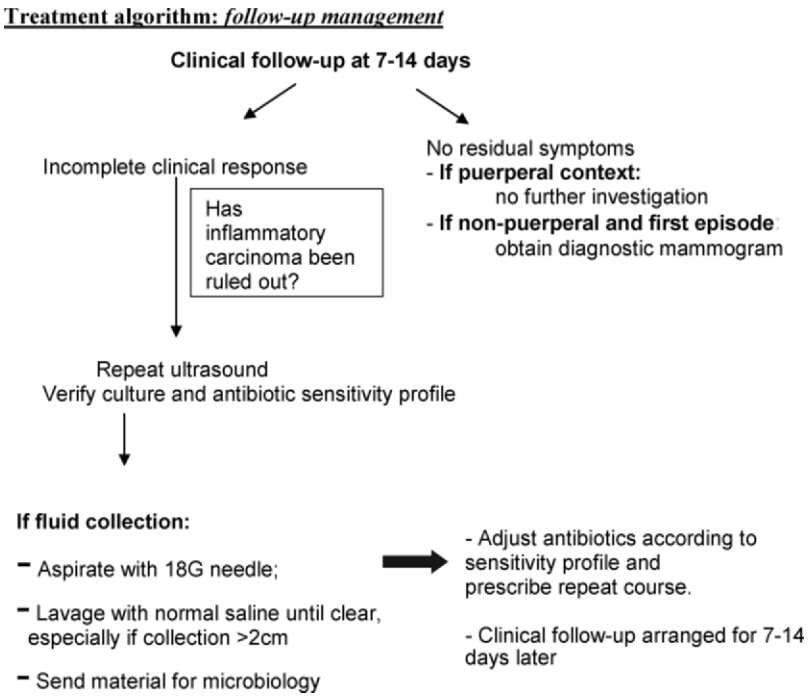

Figure 10. Proposed algorithm for first radiologic and clinical follow-up of a patient with a breast abscess. *G* = gauge.

In summary, there is overlap in the radiologic signs of inflammatory cancer and of infection, and therefore it is difficult to differentiate these two entities at imaging (19,23). Whenever there is clinical suspicion that underlying malignancy may be present because of an atypical clinical course, a personal or family history of breast cancer, or suggestive imaging findings, a breast biopsy or skin punch biopsy should be promptly performed.

Noninfectious Inflammatory Processes

Breast involvement by less common inflammatory processes must also be considered in the differential diagnosis of a breast abscess. Immunologic diseases—Churg-Strauss syndrome, amyloidosis, Wegener granulomatosis, sarcoidosis, and diabetic mastopathy—rarely involve the breast, but when they do, breast involvement is not the first manifestation of the disease (42). Inflammatory diseases of unknown origin may also affect the breast, but again rarely in an isolated fashion. For example, necrobiotic xanthogranulomatosis predominantly involves the subcutaneous fascia (42).

On the other hand, chronic idiopathic granulomatous mastitis may manifest initially in the breast and mimic an infectious process or malignancy (12,42). The clinical manifestation is a palpable mass in 89% of cases with associated pain and erythema in 11%. At mammography, the most common finding is a focal asymmetric density. US findings are variable, ranging from a large hypoechoic mass to multiple clustered, often contiguous, hypoechoic tubular lesions (42). Associated axillary adenopathy has been reported in 28% of cases (43).

The diagnosis of granulomatous mastitis is often one of exclusion, and many patients are referred after unsuccessful repeat antiobiotic courses and drainage attempts (Fig 8). Core needle biopsy leads to the correct diagnosis, which is made microscopically by identification of nonnecrotizing granulomas in which no microorganisms or features of other granulomatous illnesses are seen (43). Hovanessian Larsen et al (43) reported clinical improvement in 77% of patients after oral corticosteroid therapy, but some patients will require wide surgical excision (44).

Conclusions

We have synthesized the available literature and propose evidence-based algorithms for diagnosis, management, and follow-up of breast abscesses (Figs 9–11). These algorithms can be applied in daily practice for management of breast infections. Breast abscesses are often challenging to

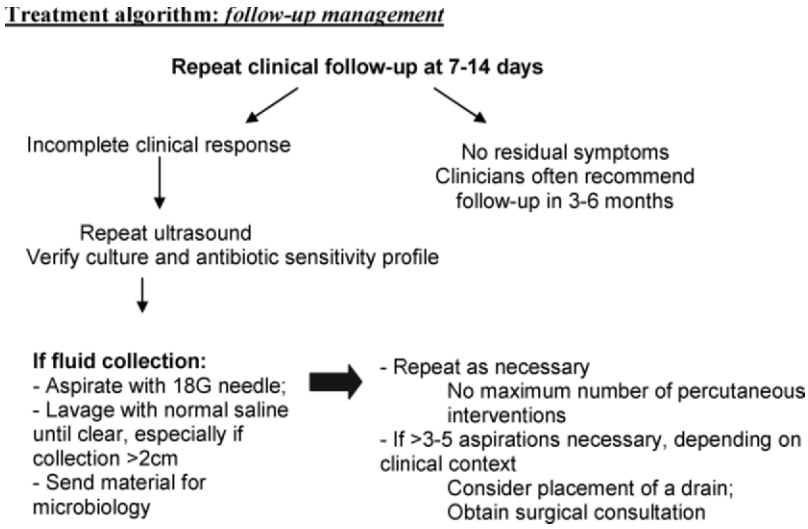

Figure 11. Proposed algorithm for continued radiologic and clinical follow-up of the patient with a breast abscess. *G* = gauge.

manage and are best treated in the radiology department, where US-guided percutaneous drainage can be performed with follow-up US to monitor treatment. The radiologist is pivotal in the treatment team, and multidisciplinary management of breast abscesses with physicians and surgeons will lead to optimal care.

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Breast Abscesses: Evidence-based Algorithms for Diagnosis, Management, and Follow-up

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Page 1684 (Figure on page 1685)
This type of abscess is more frequent in primiparous mothers (65% of cases) (5,8) and responds well to drainage and antibiotics (Fig 1).

Page 1684 (Figure on page 1686)
Central nonpuerperal abscesses are the most common form of abscesses that develop outside of the breast-feeding period. They primarily affect young women, most of whom are smokers (1,4,11) (Fig 2).

Page 1688 (Figure on page 1689)
Peripheral nonpuerperal abscesses are less common and occur at a slightly older age than central nonpuerperal abscesses and puerperal abscesses (Fig 5). They can occur in women with underlying chronic medical conditions, such as diabetes and rheumatoid arthritis. Peripheral nonpuerperal abscesses can also be encountered in women taking steroids or with recent breast interventions, such as those in the postoperative or post–radiation therapy period, although most have no associated medical conditions (1).

Page 1692
In the past 15 years, US-guided intervention has become the preferred approach. It can be performed rapidly, with local anesthesia, in ambulatory patients, with minimal to no scarring, without the need to interrupt breast-feeding, and with a complication rate similar to or lower than that of surgical incision and drainage (3,8,17,25).

Page 1694
When a patient presents with erythema and swelling but no abscess is identified at US, inflammatory carcinoma should be considered, particularly in older and nonlactating women. Some physicians suggest an initial trial of antibiotics. Nevertheless, additional investigations including mammography and biopsy should be promptly performed to differentiate between infection and malignancy, depending on the clinical context (nonpuerperal setting, family history of breast cancer) (22).