Sonography First for Subcutaneous Abscess and Cellulitis Evaluation

Srikar Adhikari, MD, RDMS, Michael Blaivas, MD

Invited paper

Video online at www.jultrasoundmed.org

The Sound Judgment Series consists of invited articles highlighting the clinical value of using ultrasound first in specific clinical diagnoses where ultrasound has shown comparative or superior value. The series is meant to serve as an educational tool for medical and sonography students and clinical practitioners and may help integrate ultrasound into clinical practice.

Received June 30, 2012, from the Department of Emergency Medicine, University of Arizona Medical School, Tucson, Arizona USA (S.A.); and Department of Emergency Medicine, Northside Hospital Forsyth, Cumming, Georgia USA (M.B.). Revision requested July 11, 2012. Revised manuscript accepted for publication July 25, 2012.

Address correspondence to Michael Blaivas, MD, Department of Emergency Medicine, Northside Hospital Forsyth, 1200 Northside Forsyth Dr, Cumming, GA 30040-1147 USA.

E-mail: mike@blaivas.org

Sonography is an ideal imaging modality for evaluation of pathologic soft tissue conditions. High resolution and the ability to perform dynamic testing such as compressing structures allow for accurate differentiation between potentially confusing physical findings. Traditionally, clinicians assumed that any area of the skin that was erythematous and showed swelling potentially harbored an abscess. Incision and drainage has long been the standard of care in such cases and was often used as a diagnostic procedure. However, studies have confirmed anecdotal clinical evidence that the physical examination is often incorrect. In fact, not only was incision and drainage being performed unnecessarily, in some cases, needed procedures were missed after failure to recognize the presence of an abscess. With the recent spread of sonography into clinical practice, multiple descriptions of point-of-care sonography use in suspected soft tissue infections have been published. Some have even noted that blind incision and drainage, once thought to be harmless, could lead to serious potential complications because not all red swollen structures should be cut with a scalpel. This article reviews clinical scenarios in which point-of-care soft tissue sonography is useful in suspected skin infections and describes pathologic findings and commonly accepted scanning approaches.

Overview and Clinical Problem

The incidence of skin and soft tissue infections has increased dramatically in recent years. The emergence of methicillin-resistant *Staphylococcus aureus* as a widespread cause of community-acquired skin infections has led to substantial increases in emergency department visits for skin and soft tissue infections. From 1996 to 2006, there was a 2-fold increase (1.2 to 2.6 million cases) in patients presenting to emergency departments with subcutaneous abscesses in the United States.[1] Many primary care settings have also seen an increase in soft tissue infections.

The most common skin and soft tissue infections encountered in clinical practice are cellulitis and abscesses. Distinction between these two clinical entities is crucial to choose the appropriate therapy. Cellulitis is treated with systemic antibiotics, and the definitive treatment of an abscess requires incision and drainage. Distinguishing cellulitis from an abscess by clinical assessment alone can be challenging even for the most experienced physician.

The appearance of the lesion is not always helpful in differentiating an abscess from cellulitis or recognizing the extent of infection. The presence of edema and induration can make it difficult to palpate an underlying abscess. Physical examination can also be limited by pain, patient compliance, and other factors. In fact, these two conditions often coexist, leading to missed abscesses.

Traditionally, physicians have relied on needle aspiration to detect the presence of an abscess in cases of diagnostic uncertainty. With this approach, patients with cellulitis but no abscess are subjected to an unnecessary, blindly performed, invasive procedure. In addition, an abscess can potentially be missed with a blind aspiration technique if the needle is not inserted in the right location. Misdiagnosis can lead to inappropriate or delayed therapy, which in turn can result in systemic complications, unnecessary return office or emergency department visits, hospitalizations, and increased costs.[2]

Sonography has been shown to be a highly sensitive tool in abscess diagnosis. It can be used to accurately differentiate an abscess from cellulitis, localize the abscess, and define the extent of infection. It can also identify foreign bodies and fluid in deeper fascial planes. In addition to its diagnostic capabilities, sonography can provide guidance for aspiration and incision and drainage and reduce potential complications, including injury to the adjacent vascular structures, tendons, and nerves.

Use of Sonography

The training required to be proficient in soft tissue sonography is minimal. Studies suggest that novice physicians can detect subcutaneous abscesses with only focused sonography training.[3] A soft tissue sonographic examination is relatively simple to perform and can be completed in a few minutes. A high-frequency (eg, 10–5 MHz) linear array transducer is typically used to perform soft tissue sonography except for peritonsillar abscess imaging, in which an endocavity transducer is used. An acoustic standoff pad can be used to enhance image resolution. Alternatively, a water bath technique may be helpful for scanning distal extremities. In addition, compound imaging and elastography can augment the sonographic evaluation.

Copious amounts of gel should be applied on the skin to enhance focusing on the most superficial layers and minimize transmitted pressure to the patient. The area of interest (erythema or swelling) is generally scanned in at least two orthogonal planes. Scanning the contralateral side or adjacent area is frequently helpful for comparison. Any fluid collection should be assessed for internal echoes, septations, and posterior acoustic enhancement. The sonographic examination includes assessment for the presence of air, foreign bodies (as a possible cause of the infection), and the depth from the skin surface to any abnormalities or vital structures. Gentle pressure should be applied to assess the compressibility and visualize motion of fluid collection contents. Additionally, color Doppler imaging is often used to evaluate the soft tissues and adjacent structures. Doppler imaging can show hypervascularity in areas of inflammation and identify as well as characterize adjacent structures such as vessels and nerves.

When evaluating for a peritonsillar abscess, imaging of the peritonsillar pillars is best performed with a high-frequency endocavity probe (eg, 9–4 MHz). Ultrasound gel is placed into a probe cover, and the transducer is placed inside the cover. Surgical lubricant may be applied on the outside of the cover. A topical anesthetic should be sprayed in the posterior pharynx for patient comfort. The probe is then inserted into the oral cavity and brought in direct contact with the peritonsillar tissue. The peritonsillar pillar is scanned in two orthogonal planes to determine the presence or absence of a fluid collection.[4]

On sonography, the skin and epidermis appear as a single echogenic layer at the frequency of the probe described in this article. The subcutaneous fatty tissue is generally hypoechoic with randomly distributed hyperechoic fibrous septa between the fat globules. The fascial planes are hyperechoic, and the muscle has a characteristic striated appearance. Vascular structures appear anechoic and linear or circular, depending on the transducer orientation. Nerves are seen as hypoechoic fascicles embedded in hyperechoic connective tissue.

The sonographic findings of cellulitis vary with the site and severity of infection. The sonographic appearances range from diffuse thickening and increased echogenicity of the skin and subcutaneous tissues to hypoechoic strands (fluid) that traverse between the hyperechoic fat and connective tissue. A characteristic "cobblestone" appearance may be seen depending on the amount of perifascial fluid, the degree of edema, and the orientation of the interlobular fat strands (Figure 1). These gray-scale appearances are not, in themselves, pathognomonic for cellulitis because similar appearances can be seen in soft tissue edema from noninfectious causes such as heart failure, lymphedema, and venous insufficiency. Color or power Doppler imaging may help identify hyperemia within the subcutaneous tissues, suggesting an inflammatory component, which is usually not a feature of noninfectious forms of edema.

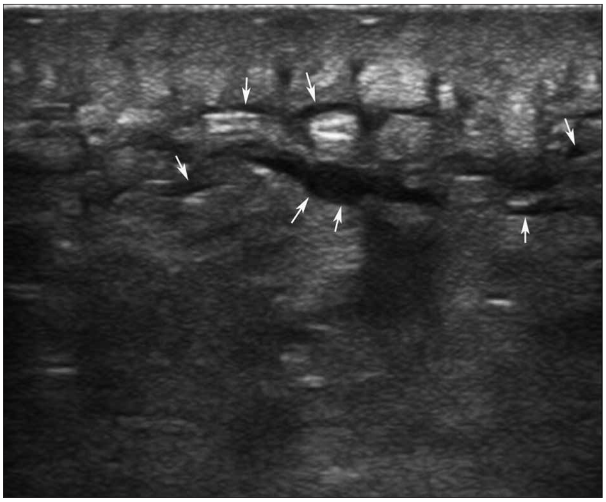
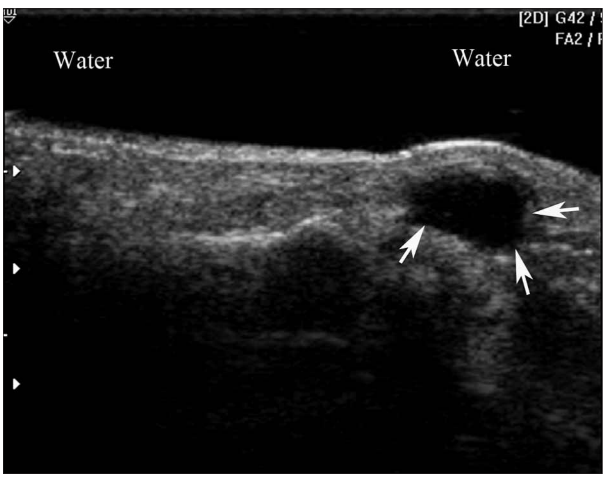


Figure 1. The cobblestone appearance is shown as fluid surrounding echogenic structures in the subcutaneous tissue (arrows).

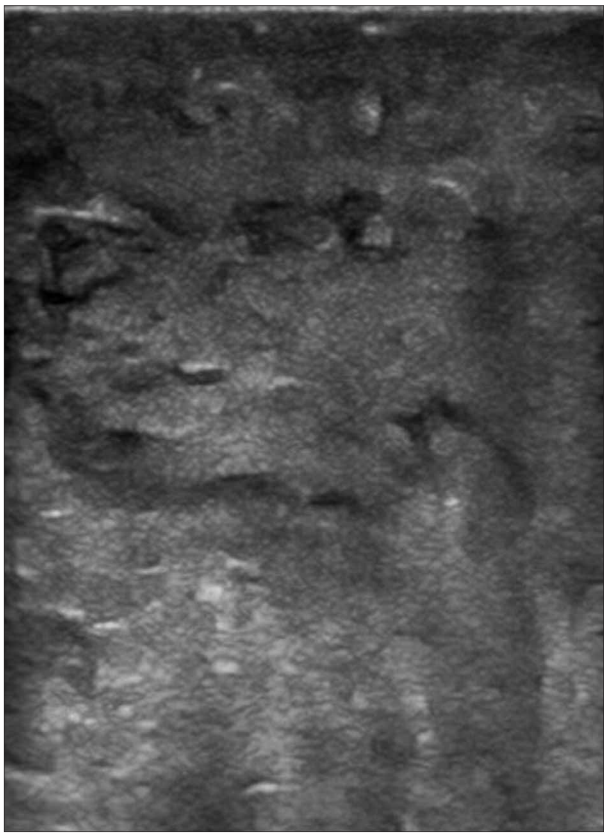
Abscesses are usually somewhat spherical with irregular or lobulated borders. The margins may be well circumscribed or poorly defined, blending with the surrounding tissues. The gray-scale appearance of a cutaneous abscess is highly variable depending on the location, maturity, and contents of the abscess cavity. The echogenicity of abscesses ranges from anechoic to hyperechoic relative to surrounding structures. An anechoic or hypoechoic complex fluid collection is the classic sonographic appearance and is easily detected (Figure 2). Occasionally, the contents of the abscess are hyperechoic or isoechoic compared to the adjacent inflamed tissues, and a mass effect is not appreciated (Figure 3). In these cases, the sonographic pattern can mimic cellulitis despite the presence of liquefaction. A variable number of internal echoes from necrotic debris are seen. Other sonographic findings of abscesses include hyperechoic sediment, septa, loculations, posterior acoustic enhancement, and hyperechoic adjacent subcutaneous tissue. Subcutaneous gas may also be visualized as acoustic shadowing or reverberation artifacts. Gentle compression of the abscess with the transducer may show movement or "swirling" of purulent material (Video 1). This maneuver reveals the liquefied abscess, which otherwise could have been overlooked. Power or color Doppler sonography usually shows hyperemia in the walls of abscesses and immediate surrounding tissues, which is a feature of inflammatory fluid collections.

Figure 2. Demonstration of the water bath technique as a very painful hand was submerged in water and scanned. A well-circumscribed abscess cavity is shown superficially (arrows).



Peripheral vein septic thrombophlebitis can present with symptoms similar to those of a cutaneous abscess and cellulitis. The sonographic findings of peripheral vein septic thrombophlebitis include a noncompressible vein with an anechoic or echogenic thrombus within the lumen, ves-

Figure 3. Isoechoic irregularly shaped abscess in the thigh. Its exact location could not be determined before probe movement and compression, which revealed fluid flow within the abscess cavity (Video 1).



sel wall thickening, and lack of color Doppler flow. A complex fluid collection representing an abscess may be visualized surrounding the vein (Figure 4). Sonography may also reveal signs of early of necrotizing fasciitis, with sensitivity and specificity reaching 88% and 93%, respectively.[5] Sonographic findings suggestive of necrotizing fasciitis include marked thickening of the subcutaneous tissues, distorted and thickened fascial layers, and an anechoic fluid collection measuring greater than 4 mm along the deep fascia. Additionally, the detection of gas (acoustic shadowing and reverberation artifacts) within the subcutaneous tissues is pathognomonic for necrotizing fasciitis. Unlike cellulitis, the inflammatory changes in necrotizing fasciitis are generally more severe and are found in deeper layers, with fluid tracking along the deep fascia.

Discussion

Multiple studies have shown the utility of sonography in the management of skin and soft tissue infections. The superiority of sonography over physical examination in identifying occult abscesses has been well established. Sonography has been shown to be superior to clinical judgment alone in identifying occult abscesses and changed management in approximately half of the patients with suspected cellulitis. Sonography can alter management in 73% of patients by eliminating unnecessary drainage procedures and further diagnostic interventions. The impact of sonography in the diagnosis and management of skin and soft tissue infections in pediatric patients is similar to that in adults. To date, multiple reports exist that show the utility of sonography in detecting a wide variety of superficial abscesses. Point-of-care sonography has been shown to be helpful in the diagnosis of orbital and perirectal abscesses and in early detection of Fournier gangrene. Peritonsillar abscesses also can be reliably identified on sonography and successfully drained under sonographic guidance. Sonography has been also found to be useful in differentiating joint effusions from soft tissue abnormalities and directing appropriate treatment.

When compared to other imaging modalities, there is evidence supporting the use of bedside sonography in the diagnosis of a dental abscess instead of panorex radiography. Sonography has been found to be more accurate than computed tomography in detecting cutaneous abscesses. In addition, it also provided more details of the abscess cavities compared to computed tomography, potentially obviating the need for ionizing radiation.[6] Given its diagnostic accuracy, ease of use, and low cost, sonography should be considered first in the diagnostic evaluation of skin and subcutaneous tissue infections.

Figure 4. Short-axis view of a thrombosed and inflamed vein. A small rim of hypoechoic fluid is shown around the wall (arrows). Th indicates thrombus.

References

1. Taira BR, Singer AJ, Thode HC Jr, Lee CC. National epidemiology of cutaneous abscesses: 1996–2005. *Am J Emerg Med* 2009; 27:289–292.
2. Iverson K, Haritos D, Thomas R, Kannikeswaran N. The effect of bedside ultrasound on diagnosis and management of soft tissue infections in a pediatric ED [published online ahead of print November 17, 2011]. *Am J Emerg Med.* doi:10.1016/j.ajem.2011.09.020.
3. Berger T, Garrido F, Green J, Lema PC, Gupta J. Bedside ultrasound performed by novices for the detection of abscess in ED patients with soft tissue infections [published online ahead of print October 24, 2011]. *Am J Emerg Med.* doi.org/10.1016/j.ajem.2011.08.002.
4. Blaivas M, Theodoro D, Duggal S. Ultrasound-guided drainage of peritonsillar abscess by the emergency physician. *Am J Emerg Med* 2003; 21:155–158.
5. Yen ZS, Wang HP, Ma HM, Chen SC, Chen WJ. Ultrasonographic screening of clinically-suspected necrotizing fasciitis. *Acad Emerg Med* 2002; 9:1448–1451.
6. Gaspari R, Dayno M, Helland G. Soft tissue ultrasound is more detailed than computed tomography for superficial abscesses [abstract]. *J Ultrasound Med* 2012; 31(suppl):S72.