# Utility of Bedside Sonography to Distinguish Soft Tissue Abnormalities From Joint Effusions in the Emergency Department

*Srikar Adhikari, MD, RDMS, Michael Blaivas, MD, RDMS*

***Objective.*** The purpose of this study was to determine the utility of bedside sonography to differentiate soft tissue abnormalities from joint effusions. ***Methods.*** We conducted a retrospective review of emergency department (ED) patients presenting with joint pain, erythema, and swelling who received bedside sonography. The ED sonographic examinations were performed by emergency physician sonologists who were not involved in clinical assessment and management of these patients. The treating physician's opinions regarding the probability of joint effusion and need for aspiration were documented in the sonography log before the sonographic examination was performed. The bedside sonograms of all patients included in this study were also reviewed for accuracy. Descriptive statistics were used to summarize the data. ***Results.*** A total of 54 patients (mean age ± SD, 41 ± 18.9 years) were identified over a 1-year period. The symptomatic joints in our study subjects were as follows: knee, 24 of 54 (44%); elbow, 21 of 54 (38%); ankle, 8 of 54 (15%); and metatarsophalangeal joint, 1 of 54 (2%). Twenty-two of 54 patients (40.7%; 95% confidence interval [CI], 27.6%–53.8%) were found to have joint effusions on sonography. Sonography altered management in 35 of 54 patients (65%; 95% CI, 52%–77.5%). Joint aspiration was planned in 39 of 54 cases (72.2%; 95% CI, 60.2%–84.1%) before sonography. After sonography, only 20 of these patients (37%; 95% CI, 24.1%–49.9%) underwent joint aspiration. There was a statistically significant difference in treatment plans after the addition of bedside sonographic results ($P < .01$). ***Conclusions.*** Our study suggests that bedside sonography is useful in differentiating joint effusions from soft tissue abnormalities and directing appropriate therapy. ***Key words:*** emergency sonography; joint cellulitis; joint effusion; joint swelling; musculoskeletal sonography; point-of-care sonography.

**Abbreviations**
CI, confidence interval; ED, emergency department

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*Address correspondence to Michael Blaivas, MD, Department of Emergency Medicine, Northside Hospital Forsyth, 1200 Northside Forsyth Dr, Cumming, GA 30041-7659 USA.*
*E-mail: mike@blaivas.org*

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Patients with musculoskeletal symptoms constitute a large portion of the patients presenting to emergency departments (EDs) in the United States. According to the 2004 National Hospital Ambulatory Medical Care Survey report, 13.8% of 110 million ED visits during 2004 were attributable to musculoskeletal symptoms.[1] Patients with joint pain and swelling are frequently seen by emergency physicians. Prompt appropriate evaluation and treatment of these patients can help limit symptoms, prevent complications, and improve outcomes. The etiology of a swollen painful joint is broad and includes conditions such as arthritis, hemarthrosis, bursitis, cellulitis, abscesses, and

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hematoma.[2] Distinction between these entities helps direct appropriate therapy. However, the diagnosis of a swollen painful joint is not always clear clinically. Signs and symptoms are neither sensitive nor specific for identifying an effusion.[3,4] Physical examination maneuvers to assess for joint effusion can be limited by pain, soft tissue swelling, patient compliance, and other factors. Traditionally, emergency physicians have relied on joint aspiration to identify the presence or absence of an effusion. With this approach, patients with isolated soft tissue abnormalities but no effusion are subjected to an unnecessary blindly performed invasive procedure.

Sonography is a rapid and sensitive technique for detecting joint effusions.[5,6] Bedside sonography is increasingly being used by emergency physicians for a wide variety of applications. The portability, accuracy, and noninvasive features of sonography make it an ideal tool for use at the bedside by trained emergency physicians. Prior studies have shown that emergency physicians are very accurate in detecting cellulitis, abscesses, and joint effusions using bedside sonography.[7–9] Bedside sonography can potentially help emergency physicians decide whether aspiration needs to be done, to request additional diagnostic imaging and consultation, or to manage with other conservative measures. To our knowledge, the role of bedside sonography in differentiating patients with swollen painful joints has not been investigated before. The objective of our study was to determine the utility of bedside sonography to differentiate soft tissue abnormalities from joint effusions.

## Materials and Methods

This was a retrospective review of ED patients presenting with joint symptoms over a 1-year period. The study was approved by the Institutional Review Board. This study took place at 2 urban EDs with an annual census of approximately 45,000 patients. Both EDs have an active emergency sonography program. Hospital-based credentialing in emergency sonography is available and is derived from American College of Emergency Physicians ultrasound guidelines.[10] Every sonographic examination performed in the ED is recorded on a DVD or an ultrasound system hard drive for quality assurance, and sonographic findings are logged separately in a log book. In the ED, all patients were evaluated by an emergency medicine staff physician.

Patients were included in the study if they presented with joint pain, erythema, or swelling and received bedside sonography. No specific ED sonographic protocol for evaluating joint symptoms was followed. Patients received bedside sonography when a credentialed emergency physician sonologist was on duty. All patients included in the study underwent a physical examination by an emergency medicine staff physician before receiving sonography. The ED sonographic examinations were performed by emergency physician sonologists who were not involved in clinical assessment and treatment of these patients. The treating physician's opinions regarding the probability of joint effusion and need for aspiration were documented in the sonography log before the sonographic examination was performed. The bedside sonographic examinations of the joints were performed using either an EnVisor system (Philips Healthcare, Bothell, WA) with a 12–5 MHz broadband linear transducer or an M-Turbo system (SonoSite, Inc, Bothell, WA) with a 13–6 MHz linear transducer. The final sonographic interpretation and diagnosis were made at the bedside by the emergency physician sonologist. The sonograms and interpretation were revealed to the treating emergency physician, and the effect of the sonographic results on the management plan was recorded. The effect on management was recorded as no effect, a new aspiration procedure, or elimination of an aspiration procedure. Sonographic guidance, either dynamic or static, was allowed for the aspiration of the joint.

The 4 emergency medicine physician sonologists who contributed to this study are credentialed by the hospital to perform sonographic examinations. All 4 emergency physician sonologists had previously taken a standardized 16-hour course on emergency sonography that included didactics and hands-on training sessions. All had at least 3 years of sonographic experience in the ED before the study, and each had performed at least 50 musculoskeletal and superficial sonographic examinations before the study.

The sonographic protocol included scanning the symptomatic joint and surrounding soft tissues in 2 orthogonal planes. To differentiate an effusion from cartilage, graded compression was used, and the anechoic area was followed along the entire length of the bone. Doppler imaging was used as necessary to evaluate the joint and adjacent structures. A sonographic examination of the contralateral joint was also performed for comparison. Figures 1–3 show sonographic findings of ankle, elbow, and knee joints.

Two chart reviewers performed data abstraction using a standardized data extraction form. The data extraction form included information about sonographic findings, final interpretation, ED assessment, hospital course, outcome, and final diagnosis. The chart reviewers were not blinded to the study hypothesis and results. Emergency department sonography logs were reviewed initially for musculoskeletal sonographic examinations. Medical records were then reviewed for history, physical examination findings, laboratory results, additional diagnostic testing, disposition plan, hospital course, and follow-up visits. Data were stored using an Excel spreadsheet (Microsoft Corporation, Redmond, WA). The bedside sonograms of all patients included in this study were also reviewed for accuracy by an emergency physician sonologist who was blinded to the study hypothesis, ED sonographic interpretations, and other clinical information.

**Figure 1.** The left panel shows a swollen and erythematous ankle suspected of having cellulitis (arrows). In the right panel, sonographic interrogation of the joint shows a fluid collection (arrows) that was aspirated.

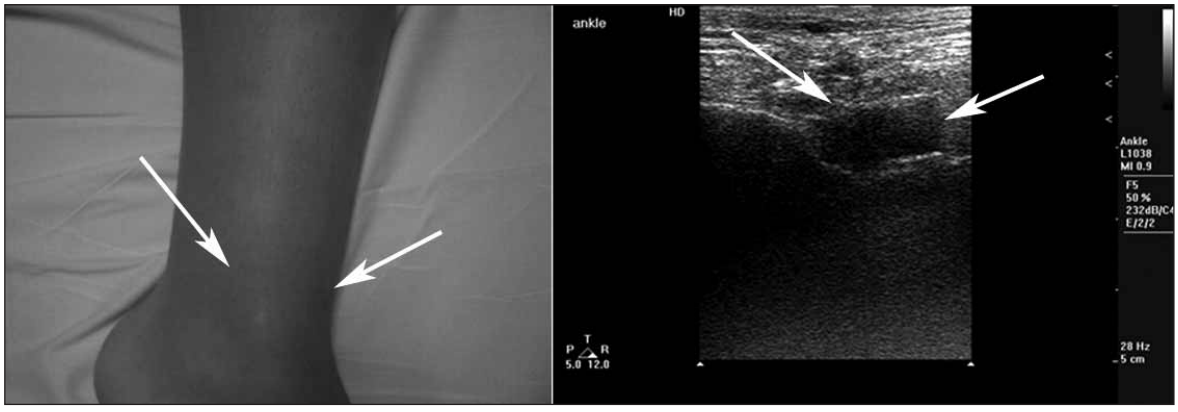


**Figure 2.** The left panel shows a patient's elbow that was erythematous, swollen, and tender (arrows). The treating physician thought that an effusion was present clinically and aspiration would be needed for this septic process. The right panel is a long-axis view of the elbow joint showing no effusion but pronounced soft tissue swelling. Aspiration was deferred.


**Figure 3.** The left panel shows a patient with a spontaneously swollen and tender knee (arrows). The treating physician suspected hemarthrosis, but there was no history of trauma or anticoagulation. The right panel is a transverse sonogram of the knee joint showing hemarthrosis (arrows).

Descriptive statistics were used to summarize the data with SAS software (SAS Institute Inc, Cary, NC). Continuous data are presented as means with SDs, and dichotomous data are presented as percent frequencies of occurrence with 95% confidence intervals (CIs). The proportion of patients whose primary treatment plan was altered by the addition of bedside sonography was determined. The McNemar test was used to determine whether there was a significant change in the management before and after sonography. The statistical level of significance used in all analyses was $P < .05$.

## Results

A total of 54 patients were identified over a 1-year period. None of the patients were excluded from analysis. The mean age of the patients was 41 ± 18.9 years. Table 1 shows the symptomatic joints in our study subjects. Twenty-two of 54 patients (40.7%; 95% CI, 27.6%–53.8%) were found to have joint effusions on sonography. Joint effusions were found in both groups in which physicians believed that joint aspiration was necessary and not necessary (Table 2).

Sonography altered management in 35 of 54 patients (65%; 95% CI, 52%–77.5%; Table 3). Joint aspiration was planned in 39 of 54 cases (72.2%; 95% CI, 60.2%–84.1%) before sonography. After sonography, only 20 of these patients (37%; 95% CI, 24.1%–49.9%) underwent joint aspiration. There was a statistically significant difference in treatment plans after the addition of bedside sonographic results ($P < .01$).

In the group in which treating physicians believed that joint aspiration needed to be done, sonography changed the management in 27 of 39 cases (69.2%; 95% CI, 54.7%–83.7%), with 12 patients receiving antibiotics for cellulitis and 15 patients receiving other conservative measures. In the group in which treating physicians believed that joint aspiration was not necessary, sonography changed the management in 8 of 15 cases (53.3%; 95% CI, 28%–78.5%). Four patients were hospitalized for septic arthritis and received intravenous antibiotics and orthopedic consultation, and 4 patients had a diagnosis of crystal arthropathy. No subsequent change in patient treatment was noted during hospitalization or follow-up visits compared with initial treatment. There was 100% agreement in the interpretation of sonograms between the ED physician sonologist and blinded investigator.

**Table 1.** Location of Joint Symptoms

| Location | n | % |
|---|---|---|
| Knee | 24 | 44 |
| Elbow | 21 | 38 |
| Ankle | 8 | 15 |
| MTP | 1 | 2 |

MTP indicates metatarsophalangeal joint.

## Discussion

Musculoskeletal symptoms often prompt visits to the ED. A large proportion of the patients seen in the ED setting present with musculoskeletal conditions. In a study done by De Lorenzo et al,[11] it was the clinical category most frequently seen in the ED. Joint symptoms represent a significant percentage of musculoskeletal conditions seen in the ED. In a 5-year study of ED patients, Derlet et al[12] found that joint pain was the most common symptom (7%). Joint disorders with a vast spectrum of age, acuity, and etiologies affect ED patients. The differential diagnosis of a swollen painful joint is extensive, including septic arthritis, crystal arthropathy, hemarthrosis, cellulitis, abscesses, and soft tissue hematoma. It is imperative that emergency physicians identify conditions that require immediate therapy from those that need less urgent intervention. Accurate early diagnosis and treatment can prevent long-term problems. However, the diagnosis is not always clear, and the evaluation of an ED patient with joint swelling can present considerable clinical management issues. Clinical criteria alone are not adequate to differentiate patients with arthritis from those with soft tissue abnormalities. Physical examination and laboratory data are not always helpful to identify the presence of an effusion. Cellulitic changes such as erythema, induration, and swelling overlying a joint can mimic a septic joint with effusion. Traditionally, emergency physicians perform joint aspiration blindly to identify the presence of a joint effusion. This approach subjects both the patient and the physician to the pain, risk, and time of an invasive procedure. In addition, small joint effusions can potentially be missed with the blind technique, and multiple attempts may be needed to confirm the absence of an effusion.

Conversely, empiric treatment with antibiotics or analgesics can delay the diagnosis of a septic joint, resulting in repeated ED visits, hospitalizations, and possible deterioration of the infection. If not diagnosed and treated in a timely fashion, septic arthritis can have devastating sequelae. Early diagnosis of septic arthritis prevents major complications such as destruction of the joint and disability. Current evidence suggests that the history, physical examination, and laboratory data are not adequate for establishing the presence or absence of septic arthritis. Synovial fluid analysis appears to be the most useful diagnostic tool in the evaluation of these patients.[13] Synovial fluid findings suggesting septic arthritis alter the acute treatment of a patient, including intravenous antibiotic therapy, orthopedic consultation, and admission. Hence, it is recommended that emergency physicians perform joint aspiration in all of these patients for synovial fluid analysis.[14]

In the absence of an effusion, joint aspiration results in a "dry tap." Unfortunately, these patients with soft tissue abnormalities are subjected to invasive procedures, only to receive antibiotics or analgesics or other conservative measures. In addition, severe dermatitis or cellulitis overlying a joint is a contraindication for joint aspiration. It is recommended to avoid this procedure in patients with cellulitis at the site of the needle entry because of the possibility of introducing infection into a sterile joint when the needle is inserted into the joint through an area of cellulitis.[15] Also, it is not safe to perform this procedure in patients with bleeding diathesis or those receiving anticoagulants. It would be ideal to know whether a joint effusion is present before introducing a needle into the joint space. This would avoid subjecting patients to a futile invasive procedure.

**Table 2.** Joint Effusion on Sonography

| Joint Effusion | Presonography Joint Aspiration Planned | | |
|---|---|---|---|
| | Yes | No | Total |
| Yes | 13 | 9 | 22 |
| No | 26 | 6 | 32 |
| Total | 39 | 15 | 54 |

**Table 3.** Change in Patient Management After Sonography

| Presonography Joint Effusion Planned | Presonography Joint Aspiration Done | | |
|---|---|---|---|
| | Yes | No | Total |
| Yes | 12 | 27 | 39 (72) |
| No | 8 | 7 | 15 (28) |
| Total (%) | 20 (37) | 34 (63) | 54 |

Sonography has been proven to be highly accurate in detecting the presence of joint effusions.[16–19] It provides the most rapid and efficient way to evaluate a patient with suspected joint infection.[20] Compared with physical examination, sonography has been shown to be both more accurate and sensitive in identifying a joint effusion.[21,22] The superiority of sonography over radiography in identifying a joint effusion has also been well established.[23,24] In addition to its diagnostic capabilities, sonography offers real-time guidance of joint fluid aspiration and can reduce the potential complications associated with contaminating other anatomic compartments and injury to adjacent nerves and vessels.[25–28]

In the past 2 decades, emergency physicians have been using sonography to help answer important focused clinical questions at the bedside.[29–31] It has become an invaluable bedside diagnostic modality in the emergency medicine setting. In addition, sonography is being used increasingly to guide procedures such as vascular access, paracentesis, pericardiocentesis, thoracentesis, and peritonsillar abscess aspiration. As a diagnostic tool, sonography is often used in conjunction with physical examination in ED patients. Prior studies have shown that sonography can be an efficient noninvasive tool for detecting cellulitis, abscesses, and joint effusions in the ED. The accuracy of sonography in differentiating cellulitis from an abscess compared with clinical examination and the impact of sonographic findings on the treatment of these patients in the ED has been well studied.[32,33] Tayal et al[34] found that sonography can show occult abscess, prevent invasive procedures, and provide guidance for further imaging and consultation. In that study, sonography was shown to be superior to clinical judgment alone in identifying an occult abscesses and changed management in approximately half of the ED patients with cellulitis.[34] In recent years, bedside sonography has been used by emergency physicians to diagnose fractures and guide fracture reduction.[35–41] Point-of-care sonography has also been used in ED patients to confirm the presence of joint effusions and guide arthrocentesis of different joints.[42–46]

To our knowledge, no prior studies have examined the role of sonography in the evaluation of patients with swollen painful joints in the ED. Our study shows that sonography can alter the treatment of these patients significantly. More than 50% of futile joint aspirations were avoided in our study group. Conversely, sonography detected joint effusions in approximately 50% of patients in whom aspiration was not planned by the treating emergency physicians. This led to accurate diagnosis and appropriate consultation and therapy. Misdiagnosis of septic arthritis in this group of patients would have led to potentially serious complications. Our study indicates that sonography is superior to clinical judgment in determining the presence or absence of a joint effusion. We acknowledge that sonographic findings do not distinguish between infectious and inflammatory effusions, and septic arthritis has a wide spectrum of imaging findings. Absence of a joint effusion does not necessarily completely exclude the possibility of septic arthritis, but absence of a joint effusion makes it very unlikely. Overall, our study results suggest that sonography is a reliable way of identifying a joint effusion and determining whether an aspiration is needed. By distinguishing soft tissue abnormalities from joint effusions, a substantial number of potentially traumatic and unnecessary aspiration attempts can be eliminated. In addition, sonography can show joint effusions that are not apparent on clinical examination, expedite the diagnosis of septic arthritis, and prevent long-term morbidity and disability.

This study had a number of limitations, including its retrospective nature. We attempted to minimize the bias in retrospective data collection by using a standardized abstraction form. The data collectors were not blinded to the study hypothesis. No ED protocol to evaluate a painful swollen joint was adopted. Not all patients with joint symptoms received bedside sonography because not all emergency physicians in our EDs are credentialed in sonography. In our study, we included only patients with joint symptoms who received bedside sonography, which introduced a selection bias. When a credentialed physician was not on duty, the decision to obtain a comprehensive sonographic examination was at the discretion of the emergency physician on duty.

We do not know the outcome of these patients in whom bedside sonography was not performed. Information regarding the total number of patients with joint symptoms and overall incidence of a dry tap or misdiagnosis in our institution during the study period was not available to the study investigators.

The presence or absence of an effusion on sonography was not confirmed by another imaging study or joint aspiration in all cases. However, the ED sonographic findings were confirmed for accuracy by another blinded sonologist. In addition, medical records of all our study patients were reviewed for any subsequent change in management compared with ED management, which was based on sonographic findings. There was no analysis of the time to diagnosis, treatment, and resolution of symptoms; hence, no conclusions can be drawn with respect to those outcomes. Our study physicians may have more scanning experience compared with an average emergency physician sonologist. Although this may limit the generalizability of these results, this study suggests that with increasing experience, emergency sonologists can diagnose effusions accurately. Another limitation of this study was the small sample size. A large prospective study that includes all ED patients with joint symptoms would have been ideal to clearly define the role of bedside sonography in the evaluation of these patients.

In conclusion, despite limited numbers, our study suggests that bedside sonography is useful in differentiating joint effusions from soft tissue abnormalities and directing appropriate therapy. Sonography is a rapid, inexpensive, and noninvasive imaging modality that can be used at the bedside in the evaluation of ED patients with joint symptoms. Bedside sonography can have a substantial impact on the treatment of these patients in the ED.

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