

A Randomized Controlled Trial of Incision and Drainage Versus Ultrasonographically Guided Needle Aspiration for Skin Abscesses and the Effect of Methicillin-Resistant *Staphylococcus aureus*

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Study objective: The incidence of skin and soft tissue infections has increased dramatically during the last decade, in part because of increased prevalence of community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA). Incision and drainage is considered the primary intervention; however, some clinicians prefer ultrasonographically guided needle aspiration because it represents a less invasive alternative. Our hypothesis is that ultrasonographically guided needle aspiration is equivalent to incision and drainage in treating simple skin and soft tissue abscesses.

Methods: This study was a nonblinded randomized controlled trial. Patients with uncomplicated superficial abscesses were randomized to incision and drainage with packing or ultrasonographically guided needle aspiration. Purulence obtained from the abscess was cultured to identify the causative organism. Bedside ultrasonography was performed pre- and postintervention to confirm the presence or absence of an abscess cavity. Patients were followed up at 48 hours (in person by a clinician) and on day 7 (telephone follow-up by research staff). The primary outcome was a combination of sonographic resolution and clinical resolution of the signs and symptoms of ongoing infection at day 7. The signs and symptoms of ongoing infection include increasing pain, erythema, and the presence of pus. Resolution was assessed with both sonographic resolution (day 0 and day 2) and improvement of clinical symptoms (day 2) and resolution of clinical symptoms (day 7) without further intervention.

Results: A total of 101 patients were enrolled, 54 incision and drainage and 47 ultrasonographically guided needle aspiration patients. At initial presentation, 60% (95% confidence interval [CI] 45% to 70%) of needle aspirations yielded little or no purulence, despite sonographic visualization of an abscess cavity and sonographic guidance during the procedure. The overall success of ultrasonographically guided needle aspiration was 26% (95% CI 18% to 44%) compared with 80% (95% CI 66% to 89%) success in patients randomized to incision and drainage. The difference between groups was 54% (95% CI 35% to 69%). Overall success of both incision and drainage and ultrasonographically guided needle aspiration was lower in patients with CA-MRSA. Patients with CA-MRSA (n=33) were less likely to receive successful drainage with needle aspiration (8% versus 55%) or incision and drainage (61% versus 89%). The difference for needle aspiration and incision and drainage was 47% (95% CI 15% to 57%) and 28% (95% CI 4% to 45%), respectively.

Conclusion: Ultrasonographically guided needle aspiration is insufficient therapy for skin abscesses. The presence of CA-MRSA decreases the success of both incision and drainage and ultrasonographically guided needle aspiration. [Ann Emerg Med. 2011;57:483-491.]

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INTRODUCTION

Background

Surgical incision and drainage with or without antibiotics is the treatment of choice for skin and soft tissue abscesses^{1,2} regardless of causative organism. Ultrasonographically guided needle aspiration has been advocated as an alternative to

incision and drainage for some superficial abscesses,³⁻⁵ but it remains unclear whether needle aspiration is a feasible treatment option for general skin and soft tissue abscesses. Although some practitioners have adopted needle aspiration as an alternative management strategy for superficial abscesses, there remains a need for randomized

Editor's Capsule Summary

What is already known on this topic

Incision and drainage is the primary treatment for skin abscesses.

What question this study addressed

Incision and drainage was compared with ultrasonographically guided needle aspiration for 101 patients with uncomplicated skin abscesses. Success was defined as complete drainage documented by ultrasonography and resolution of symptoms at day 7.

What this study adds to our knowledge

Ultrasonographically guided needle aspiration was successful in only 30% of patients compared with 80% success with incision and drainage. Most patients failed needle drainage at the initial attempt.

How this is relevant to clinical practice

Incision and drainage should remain the primary method for draining uncomplicated skin abscesses.

studies investigating the feasibility of the technique relative to incision and drainage. If proven effective, needle aspiration could allow for decreased pain, decreased scarring, and increased patient satisfaction.

Skin and soft tissue infections have more than doubled from 1996 to 2005, with more than 3 million patients with abscesses presenting to emergency departments (EDs) each year.⁶ During the last decade, community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) infections have increased dramatically,^{7,8} with the reported percentage of skin infections caused by CA-MRSA varying widely between 15% and 74%.⁹ The increasing percentage of CA-MRSA has raised questions concerning the appropriateness of therapy for skin and soft tissue infections.

Importance

Recent clinical trials have focused almost exclusively on antibiotic therapy,^{10,11} whereas the effect of CA-MRSA on treatment failure after surgical drainage (independent of altering antibiotic regimen) remains unknown.

Goals of This Investigation

Our primary goal was to determine whether the proportion who fail treatment after ultrasonographically guided needle aspiration is equivalent to the proportion who fail after incision and drainage, for patients with uncomplicated skin and soft tissue infections. Our secondary goal was to determine whether treatment failure was affected by CA-MRSA infection. Our specific hypothesis was clinical, and sonographic abscess cavity

resolution after ultrasonographically guided needle aspiration is equivalent to resolution after incision and drainage for patients with skin and soft tissue abscesses who present to the ED.

MATERIALS AND METHODS

Study Design

This study was a prospective, nonblinded, randomized controlled trial. The study was performed during a 15-month period, from August 2008 to November 2009.

Setting

The study was conducted at 2 separate urban academic EDs in the United States. Institutional review boards at both sites approved this study. Both EDs are teaching hospitals with emergency medicine residencies, with an annual census of 85,000 and 53,000.

Selection of Participants

Healthy-appearing patients were eligible for inclusion if they presented with an uncomplicated, superficial skin abscess verified by history, physical examination, and bedside ultrasonography. Patients were excluded if they were younger than 18 years, pregnant, or unable to give consent, or if the location of the abscess was dental, peritonsillar, genital, or intragluteal at the base of the coccyx. Complicated abscesses, defined as an abscess with associated sepsis, lymphangitis, osteomyelitis, or cellulitis extending beyond the abscess cavity and surrounding induration, were excluded. Only abscesses of superficial structures not including deeper structures such as bones and organs were included. No abscesses were excluded because of size of the abscess cavity. Informed written consent was obtained before enrollment and randomization.

Patient enrollment was 24 hours a day, 7 days a week, but an element of convenience sampling existed because research staff was periodically not available on nights or weekends. About half of individuals were identified as possibly eligible by ED clinical staff but were not enrolled because of lack of research staff.

Data Collection and Processing

Data were collected on a preprinted data sheet by physician research staff performing the drainage procedure (R.J.G., D.R., M.M., T.K., D.B.). Patient-related data included sex, age, duration of symptoms, diabetes mellitus, history of abscess or MRSA, presence of cellulitis or purulent discharge, abscess location, and patient disposition after abscess drainage. The abscess fluctuance and surrounding induration were measured in centimeters with skin measurement rulers before surgical intervention. Standardization of abscess measurements was performed by reviewing measurement procedure with each researcher involved in the study before initiating the study. No interrelater reliability was assessed between researchers. Specimens of abscess purulence were obtained from the largest area of infection with sterile culture swabs and were processed according to standard laboratory techniques. The amount of pus was estimated after incision and drainage and directly measured with the syringe markings during needle aspiration.

Ultrasonographic images were obtained with a high-frequency linear array transducer on one of several ultrasonographic machines available in the ED (Ultrasonix, Richmond, British Columbia, Canada; Zonare, Mountain View, CA; Sonosite, Bothell, WA). Three sets of sonographic images were obtained: at presentation, after surgical drainage, and at 48-hour follow-up. Images included long-axis and short-axis views of the abscess cavity, images of the soft tissue surrounding the abscess cavity, and comparable images of the contralateral side. Abscess depth was measured on the ultrasonographic images from the skin surface to the most superficial part of the abscess cavity with digital calipers. Postdrainage imaging was included as well after each attempt, and air artifact limited imaging quality, but satellite lesions and residual cavity purulence remained visible lateral to the air artifact and were easily identifiable. All sonographic images were recorded in digital format and later blindly reviewed at the end of the study.

Interventions

Patients were randomized at presentation to one of 2 groups, ultrasonographically guided needle aspiration or incision and drainage. Each site independently randomized the individuals at their site. Randomization was performed at the level of the patient, with the physician using blind-sequenced trial packs. Patient allocation was determined after informed consent and was unknown until the initial procedure. The individual trial packs were made up and assigned a random number with a random-number generator (Graphpad, La Jolla, CA) by R.J.G. and contained group assignment, physician instructions, data sheets, and follow-up instructions for the patient. We used a partial crossover design in which patients who failed ultrasonographically guided needle aspiration were converted to incision and drainage and patients who failed initial incision and drainage underwent additional surgical exploration of the wound. Physician investigators involved in this study performed all drainage procedures.

Patients randomized to ultrasonographically guided needle aspiration underwent needle drainage of the abscess cavity with ultrasonographic guidance. After sonographic localization of the cavity, the site was prepared and draped with local anesthetic infiltrated at the site of needle placement. Under direct sonographic visualization, a needle (18 gauge or larger) attached to a 40-mL syringe was advanced into the abscess cavity with manual negative pressure. Purulent material was aspirated until no further purulence could be aspirated, and the resolution of the abscess cavity was confirmed by postprocedure ultrasonography. Multiple aspiration attempts were allowed at the initial visit to fully drain the abscess cavity or cavities. Failure of ultrasonographically guided needle aspiration was defined as the inability to fully aspirate all abscess cavity contents and resulted in immediate incision and drainage.

Patient randomized to incision and drainage underwent incision and drainage in standard fashion. Briefly, after location of the abscess cavity with ultrasonography, the skin surface was

infiltrated with local anesthetic. The ultrasonographic probe was placed aside before incision of the skin surface over the largest area of infection. Incision of the skin and soft tissue was performed with a number 11-blade scalpel, with penetration into the abscess cavity. A blunt instrument was then used to break any internal loculations. Repeated instrumentation through a single incision or extension of the original incision was performed if needed, and iodoform packing was inserted through the skin incision at the end of the procedure. Sonographic imaging was performed postprocedure to confirm resolution of the abscess cavity by placing gel over the incision and imaging the abscess cavity before packing the wound. Patients were instructed to change the dressing daily but avoid disturbing the packing material until the 48-hour follow-up. At the 48-hour follow-up, the wound packing was removed and the wound was left unpacked.

Patients were prescribed antibiotics at the discretion of the physician of record, but research staff made recommendations in an attempt to standardize therapy. Recommendations for all patients consisted of trimethoprim-sulfamethoxazole (320 mg/1,600 mg every 12 hours×1 week) for all patients in the study unless limited by drug allergy and additional cephalexin (500 mg every 6 hours×1 week) for patients with cellulitis.

All patients enrolled in the study were asked to return for a follow-up examination and ultrasonography 48 hours after the initial drainage procedure. In addition, patients were contacted by telephone at least 7 days after the initial visit, and study personnel performed a structured interview to ascertain treatment failure. Existing research personnel performing telephone follow-up on other ongoing research projects in our department were used for 7-day telephone follow-up. They were blinded to study group allocation and asked a series of questions from a preprinted data form (Appendix E1, available online at <http://www.annemergmed.com>). For patients for whom telephone follow-up was unavailable, a structured review of patient record was performed at the termination of the study. Outcomes determined by chart review consisted solely of transcribed reports detailing follow-up specific to the abscess cavity by either the primary care physician or surgery clinic.

Outcome Measures

The primary outcome was treatment failure at the end of the study, defined by a combination of sonographic and clinical findings. Secondary outcomes included treatment failure at presentation and clinical follow-up on day 2. A patient who was classified as experiencing a failure at any point was considered to have experienced a failure at the study endpoint (day 7) for data analysis purposes.

Treatment failure was determined at 3 points during the study (days 0, 2, and 7) with a combination of sonographic and clinical variables, as has been advocated previously.¹² The initial component of treatment failure on day 0 reflected the inability to physically drain the purulence and included a sonographic evaluation postdrainage to verify any residual abscess cavity. On day 2, treatment failure was defined by a combination of

sonographic evidence of a residual abscess cavity after manual expression and increasing clinical symptoms (redness, swelling, or fever). Any patients with additional interventions (surgery or antibiotics) were classified as experiencing a treatment failure. Treatment failure on day 7 was defined by a continuation of clinical symptoms or additional interventions (surgical abscess drainage or change in antibiotics). In all cases, research personnel were responsible for the final determination of treatment failure.

Treatment failure was not definitive in some cases in which the abscess cavity was smaller. Patients randomized to ultrasonographically guided needle aspiration with only a small amount of purulence (<0.5 mL) underwent incision and drainage when sonographic imaging was inconclusive to determine whether purulent material remained. These patients were classified as having experienced a treatment failure if the incision and drainage demonstrated additional purulence. Patients randomized to incision and drainage with only a small amount of purulence (<0.5 mL) underwent additional manual exploration for the same reason. These patients were classified as having experienced a treatment failure if sonographic evaluation after incision and drainage demonstrated a residual abscess cavity.

Treatment failure by telephone follow-up on day 7 involved research staff asking a series of prepared questions concerning patient symptoms and events, specifically symptomatic improvement in pain, swelling, redness, drainage, and constitutional symptoms. The patient was asked whether he or she was treated since the initial ED visit by any other physician, whether any further procedures were performed on the abscess, and whether he or she began receiving any new medications for the abscess and to name the new medications if so.

Primary Data Analysis

All patients included in this study were analyzed following intent-to-treat principles unless otherwise noted. Data are presented as value (95% confidence interval [CI]) unless otherwise specified. For the purpose of the prespecified subgroup analysis, patients were classified as CA-MRSA positive or CA-MRSA negative. A multivariate regression was used to determine whether failure of therapy was related to CA-MRSA and independent of the drainage procedure. The initial power calculation was planned as an equivalency test and assumes a clinically important absolute difference between groups of 15% and a success rate of 83% in the incision and drainage group, using an online sample-size calculator for difference between 2 sample percentages (available at <http://www.dssresearch.com>). With $\alpha = .05$ and $\beta = .80$, a sample size of 98 for both groups was required.

An interim analysis of data was performed after 30 patients to ensure patient safety in the ultrasonographically guided needle aspiration group. This analysis was performed by a physician research (R.J.G.) unblinded to assignment group. The stopping rules included adverse events greater than 10% in

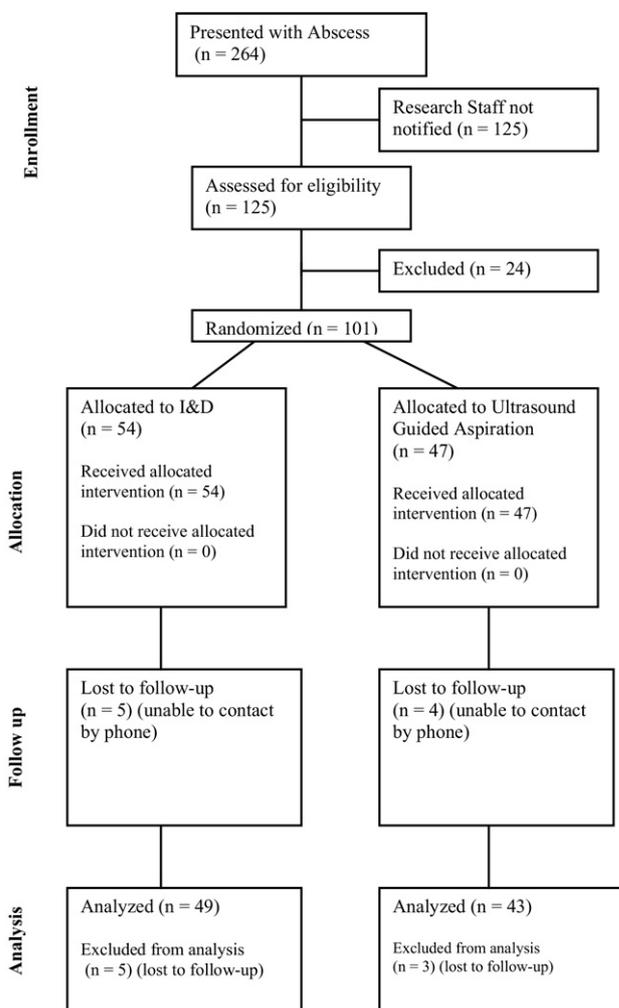


Figure 1. Flow chart for patient enrollment. *I&D*, Incision and drainage.

either assignment group. No adjustment of the initial power calculation was performed after the interim analysis.

RESULTS

Figure 1 depicts a flow chart for patients enrolled in the study. One hundred one adult patients presenting with a skin abscess were randomized to incision and drainage (n=54) or ultrasonographically guided needle aspiration (n=47). Twenty-six patients initially randomized to ultrasonographically guided needle aspiration underwent incision and drainage at presentation because of failure of therapy. Outcome data were available on 91% (92 of 101) of patients enrolled in the study. Loss to follow-up occurred on day 2 (incision and drainage n=3, aspiration n=1) and at 7 day (incision and drainage n=2, aspiration n=2).

Characteristics of Study Subjects

History and physical examination findings were similar between groups (Table 1), with a few exceptions. The size of

Table 1. Patient and abscess characteristics.*

Characteristic	Incision and Drainage (n=54)	Ultrasonographic Needle Aspiration (n=47)
Male sex, %	46 (34–59)	49 (35–63)
Age, y	38.2 (14.2)	34.6 (13.4)
Days to presentation [†]	4 (2–30)	4 (2–30)
PMHx of MRSA, %	15 (7–29)	17 (7–32)
PMHx IDDM, %	13 (6–25)	9 (3–20)
Purulent drainage before first visit, %	24 (15–37)	32 (20–46)
Area of induration, † cm ²	13.4 (31.8)	10.3 (13.5)
Area of fluctuance, † cm ²	4.9 (13.9)	2.79 (6.06)
Percentage with overlying cellulitis	72 (59–82)	52 (38–67)
Location of abscess (%)		
Head and neck	7 (13)	4 (9)
Torso	3 (6)	8 (17)
Axilla and groin	16 (30)	13 (28)
Extremities	19 (35)	15 (32)
Buttock	9 (17)	7 (15)
Depth of abscess	1.31 (1.1–1.5)	1.28 (1.1–1.5)
Average abscess volume, cc [range]	3.12 (2.1–4.2) [0.1–17]	4.88 (2.3–7.5) [0.14–37]

PMHx, Past medical history; IDDM, insulin dependent diabetes mellitus.

*Data are presented as percentage (95% CI) or average (SD) unless otherwise specified.

[†]Data are presented as median (range).

[†]Area of abscess fluctuance and induration was calculated with the following equation, in centimeters: (length×width)×0.8.

soft tissue induration and fluctuance differed slightly between groups. Overlying cellulitis was present in a large percentage of patients randomized to both incision and drainage (72%; 95% CI 59% to 82%) and ultrasonographically guided needle aspiration (52%; 95% CI 38% to 67%).

Abscesses were slightly larger in patients randomized to incision and drainage, but it is unclear why this occurred. One possibility relates to the randomization process. The sequenced trial packs were located in the ED, and on a number of occasions a trial pack disappeared and was not available for use in the study. This may also explain why there is a difference in numbers between groups despite randomization. It is possible that this was related to individuals who attempted to randomize the patient but declined or switched packets when the allocation group was revealed, but this is purely speculative. No other irregularities during randomization were reported.

Main Results

Staphylococcus aureus was isolated in 64 of 101 (63%) patients (Table 2). Thirty-three of the *S aureus* isolates (52%) were MRSA. There was no difference in the percentage of MRSA in either group: 38% randomized to ultrasonographically guided needle aspiration and 35% to incision and drainage. Eight of the 16 patients with no single bacterial pathogen isolated on culture (mixed Gram-positive growth or no growth at all) admitting to receiving antibiotics before presenting for therapy. The bacterial pathogens isolated from the skin abscesses were 7.1% clindamycin resistant and 1.8% trimethoprim-sulfamethoxazole resistant.

Table 3 and Figure 2 details outcomes at each point of the study (day 0, day 2, and overall). At initial presentation, 60% (45% to 70%) of needle aspirations yielded little or no

Table 2. Abscess culture results.

Culture Result	Incision and Drainage (%)	Ultrasonographically Guided Needle Aspiration (%)	Total (%)
MRSA	18 (35)	15 (38)	33 (36)
MSSA	20 (39)	11 (28)	31 (34)
Group A strep	1 (2)	1 (3)	2 (2)
Other	3 (6)	6 (15)	9 (10)
No culture growth	4 (8)	2 (5)	6 (7)
Mixed growth	5 (10)	5 (13)	7 (11)

MSSA, Methicillin-sensitive *S aureus*; strep, streptococcus.

Table 3. Treatment failure of incision and drainage and ultrasonographically guided needle aspiration.*

Date of follow-up	Incision and Drainage (N=54) (%)	Ultrasonographically Guided Needle Aspiration (N=47) (%)	Difference Between Groups, % (95% CI)
Day 0	2 of 54 (4)	28 of 47 (60)	56 (41 to 62)
Day 2	4 of 49 (8)	3 of 18 (17)	9 (–6 to 25)
Day 7	4 of 43 (9)	1 of 11 (9)	2 (–22 to 10)
Total	10 of 49 (20)	32 of 43 (74)	54 (35 to 69)

*Data are presented as failures (number of patients) of total number (number of patients). Patients who failed at a previous point are not included in the denominator for later points. Loss to follow-up occurred on day 2 (incision and drainage n=3, aspiration n=1) and at day 7 (incision and drainage n=2, aspiration n=2).

purulence, despite sonographic visualization of an abscess cavity and sonographic guidance during the procedure. Three of the needle aspirations were incomplete, requiring incision and drainage to completely evacuate the abscess contents. At 2-day follow-up, 3 additional patients with increased clinical symptoms or a sonographically visible abscess cavity required

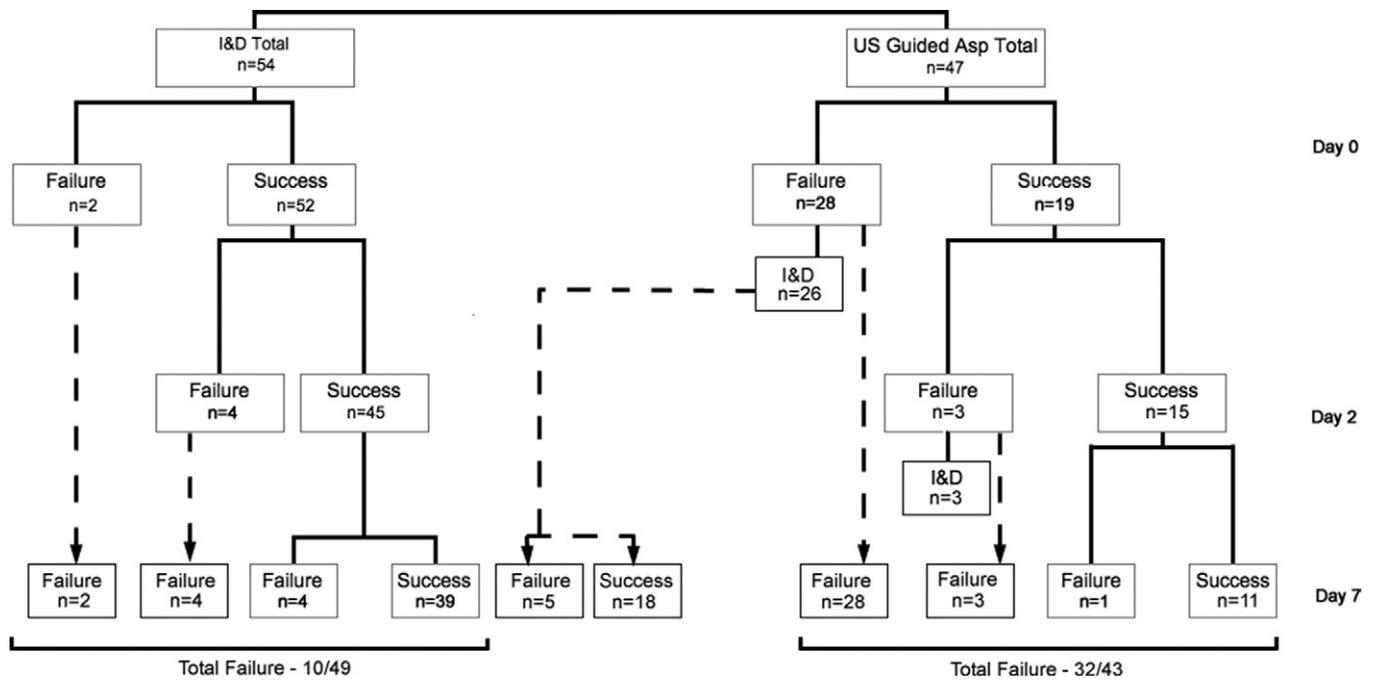


Figure 2. Study flow diagram. Flow diagram details patient outcome for individuals randomized to one of 2 groups, incision and drainage or ultrasonographically guided needle aspiration. Patients who failed therapy at any point (day 0, 2, or 7) were considered to have experienced a failure at study endpoint. Brackets at the bottom depict overall treatment failure for each group, using intention-to-treat principles. Dotted lines depict individuals who received an incision and drainage after a failed needle aspiration to allow a second analysis of failure of incision and drainage irrespective of group randomization.

incision and drainage. Two patients who failed needle aspiration at presentation initially refused incision and drainage, and both required incision and drainage at 48-hour follow-up. None of the remaining patients treated with ultrasonographically guided needle aspiration required additional treatment by surgery or primary care. The overall treatment failure for ultrasonographically guided needle aspiration was 74% (56% to 82%).

Four percent (0% to 13%) randomized to incision and drainage demonstrated treatment failure on day 0. Two patients without purulence after incision and drainage underwent multiple attempts, without success. Neither of these patients required further intervention, but they were characterized as experiencing failures according to the predetermined definition of treatment failure. At 2-day follow-up, 4 additional patients demonstrated treatment failure. The overall treatment failure rate after incision and drainage was 20% (11% to 34%), with 8 patients requiring repeated incision and drainage or surgical exploration of the wound and 2 patients requiring hospitalization for intravenous antibiotics. Performing a sensitivity analysis and analyzing all patients who received an incision and drainage regardless of the initial randomization demonstrates treatment failure in 15 of 72 patients, or 21% (12% to 30%).

Treatment failure for both incision and drainage and ultrasonographically guided needle aspiration was greater in

patients with CA-MRSA. Twelve of 13 CA-MRSA-positive patients randomized to ultrasonographically guided needle aspiration demonstrated treatment failure compared with 10 of 22 CA-MRSA-negative, patients with a difference between groups of 47% (17% to 57%). Incision and drainage demonstrated a lower proportion of treatment failure in patients without MRSA, with 3 of 28 failing therapy compared with 7 of 18 for patients with MRSA (difference between groups of 28%; 4% to 45%). A multivariate analysis comparing outcomes of CA-MRSA and non-CA-MRSA shows that failure of therapy was independent of the drainage procedure. In other words, MRSA is an independent risk factor for failure of therapy.

Most patients (ultrasonographically guided needle aspiration [43 of 47] and incision and drainage [51 of 55]) received antibiotics. The majority of patients randomized to ultrasonographically guided needle aspiration received trimethoprim/sulfamethoxazole (n=38) and a minority received vancomycin (n=3) or doxycycline (n=2). Similar antibiotic choices were observed in patients randomized to incision and drainage, with 44 receiving trimethoprim/sulfamethoxazole, 5 receiving vancomycin, and 1 receiving ampicillin/sulbactam. Fourteen patients randomized to ultrasonographically guided needle aspiration and 28 to incision and drainage received cephalexin. The percentage of patients receiving appropriate antibiotics (as determined by later culture results) was equal

between study groups (93% incision and drainage versus 92% ultrasonographically guided needle aspiration).

LIMITATIONS

There were several limitations in our study that warrant discussion. Although the primary outcome was identical between groups, because of a possible preexisting bias toward incision and drainage as the better drainage method (expressed by many nonstudy physicians with patients enrolled in this study), patients allocated to needle aspiration may have been more likely to be categorized as experiencing a failure and converted to incision and drainage, whereas those categorized as incision and drainage patients simply underwent additional incision and drainage. The study is limited by a small sample size, including baseline differences between groups and potential confounding by treatment difference outside of drainage procedures. It is possible the differences between group baselines indicate a problem with randomization. It could be argued that 7-day follow-up was not long enough to capture all failures. We chose 7-day follow-up because previous literature supports abscess healing after surgical intervention within this period.¹³ The study may be limited by the subjective determination of primary outcome.

Another limitation concerns the lack of blinding once the patient was allocated to a treatment group. A researcher with an inherent bias toward incision and drainage may be more likely to declare the needle aspiration a failure during the postprocedure ultrasonography. This was limited by the definition of treatment failure, which required that the follow-up incision and drainage produce pus to categorize the aspiration as a failure.

Finally, antibiotic treatment was not standardized for 100% of the patients. Although study personnel made recommendations for antibiotic coverage, the decision was ultimately that of the treating physician, and some physicians opted to not use any antibiotics. This did not seem to bias the results because both groups were equally affected. More important, multiple previous studies have implied that antibiotics do not contribute to the resolution of a drained abscess, so this should have little effect on clinical outcome.

DISCUSSION

There has been a wide acceptance of aspiration and catheter drainage for intra-abdominal and other deep tissue abscesses,¹⁴ but research into percutaneous drainage of superficial infections has been less well studied,^{12,15-17} and to our knowledge there has been no published research examining the effect of CA-MRSA on needle aspiration. In our study, we found a high proportion of treatment failure for needle aspiration, with an increase in patients with CA-MRSA. The previously published failure rates for aspiration of superficial breast or head and neck infections averages 24% (range 10% to 44%),^{5,16-20} lower than that of the proportion of patients who failed treatment in this

study (70%). This difference may be explained in part by differences in both the technique and the research methodology. Previous studies were largely retrospective, with a majority of patients treated using multiple aspirations or prolonged catheter drainage, and the results may not be directly comparable.

It is possible because of the study design that needle aspiration is a more effective alternative than our results indicate. The conservative nature of our study design and the reliance on ultrasonography to indicate treatment failure may not have allowed the needle aspiration to succeed. It is possible that if those patients did not receive an incision and drainage, the abscess cavity would have resolved without further interventions. Two lines of evidence support the contrary argument, ie, needle aspiration alone is insufficient. First, the majority of failures in ultrasonographically guided needle aspiration occurred because only a small portion (0 to 0.5 mL) of purulence could physically be aspirated despite multiple attempts. Second, 2 patients who refused incision and drainage after failed aspiration attempts returned on day 2 with worsening symptoms and required incision and drainage at that time. It remains a possibility that partially aspirated abscess cavities will resolve without further intervention, but further research is required.

Needle aspiration may continue to have limited clinical indications for abscesses for which immediate incision and drainage is less desirable (such as facial abscesses). It is possible that the ability to effectively aspirate purulence is sufficient for successful therapy. The majority of patients who failed needle aspiration did so on day 0, but those patients who received successful aspiration experienced a similar failure ratio with incision and drainage (17% [5% to 40%] versus 8% [2% to 19%]). However, our results demonstrate that the lack of purulence during needle aspiration is insufficient to conclude that an abscess is absent. Although our study did not address this specific question, our experience during this study leads us to believe that any attempt at needle aspiration should be accompanied by ultrasonographic guidance to provide assurance of appropriate needle placement. Many abscesses that seemed to be adequately drained demonstrated satellite lesions by ultrasonography that required further drainage.

We also found an increase in treatment failure for incision and drainage associated with CA-MRSA. Treatment failures in patients with non-MRSA (11%) match previously published results, but failure in patients with CA-MRSA was higher (39%). A review of the literature supports a causative link between MRSA and failure of incision and drainage. Decreasing success rates during the past decade mirror increasing trends in CA-MRSA prevalence. Failure rates before 2000 average 3% (range 0% to 13%)²¹⁻³² compared with failure in 13% (range 5% to 26%) during the last decade.³³⁻³⁷ However, previously published articles rarely describe the surgical drainage or define failure of therapy in great detail, making comparisons difficult. Furthermore, although some include information on CA-MRSA, they do not analyze their data in regard to

treatment failure after incision and drainage. It is also possible that there is a publication bias against negative outcomes, resulting in an increase in the published success rate of incision and drainage.

Two physical characteristics of the abscess cavity may have contributed to treatment failure: viscosity and compartmentalization of the abscess cavity. Despite sonographic confirmation of needle placement, most failures of needle aspiration occurred because of an inability to physically aspirate purulence, suggesting increased viscosity of the purulent material. Compartmentalization of the abscess cavity may also have contributed because satellite lesions were identified during ultrasonography on some patients and loculations or septations were encountered during incision and drainage. These difficulties are not unique to skin and soft tissue infections because similar difficulties have been identified after the aspiration of intra-abdominal and deeper extremity abscesses.^{12,38} Our findings suggest that CA-MRSA may induce changes in abscess characteristics, with more septations and satellite lesions.

In summary, treatment failure after ultrasonographically guided needle aspiration is unacceptably high, and our data do not support the use of needle aspiration as a therapeutic drainage technique for skin and soft tissue infections. Patients with MRSA-positive abscesses may have a higher likelihood of failure after surgical drainage than those with non-MRSA infections.

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APPENDIX E1.

Follow-up questionnaire

TELEPHONE FOLLOW UP – (7-10 days LATER)

Date –

Days from initial I&D –

Patient is overall Improved Same Worse

Pain Improved Same Worse

 Constitutional Sx
(fever, feels ill) Improved Same WorseAbscess is
(Firm and soft area) Improved Same Worse Is there any drainage Yes No
 Amount of drainage Scant Little A lotCellulitis is
(red area) Improved Same WorseDoes the red area extend beyond the line drawn by the ED doctor (outline of red area from ED)
 Yes No

Patient has been seen since initial ED by PMD Another ED Other

Since initial ED the patient has had new antibiotic started. Yes No

Name of Antibiotic:

Since initial ED the patient has had another drainage procedure done. Yes No

Since initial ED the patient has been admitted to the hospital. Yes No

Additional INFO –

Complications:Medications:Additional Visits:

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