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ORIGINAL RESEARCH CONTRIBUTION

Randomized Trial Comparing Intraoral Ultrasound to Landmark-based Needle Aspiration in Patients with Suspected Peritonsillar Abscess

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Abstract

Objectives: Traditionally, emergency physicians (EPs) have used anatomic landmark-based needle aspiration to drain peritonsillar abscesses (PTAs). If this failed, an imaging study and/or consultation with another service to perform the drainage is obtained. Recently, some EPs have used ultrasound (US) to guide PTA drainage. This study seeks to determine which initial approach leads to greater successful drainage. The primary objective of this study was to compare the diagnostic accuracy of EPs for detecting PTA or peritonsillar cellulitis (PTC) using either intraoral US or initial needle aspiration after visual inspection (the landmark technique [LM]). Secondary objectives included the successful aspiration of purulent material in those patients with a PTA in each arm, the use of computed tomography (CT) scanning in each arm, and the otolaryngology (ENT) consultation rate in each arm.

Methods: This was a prospective, randomized, controlled clinical trial of a convenience sample of adult patients who presented to a single, large, urban university hospital. Patients were enrolled if they presented with a constellation of signs and symptoms that were judged to be a PTA. These patients were randomized to receive intraoral US or to undergo LM drainage. The US was performed using an 8–5 MHz intracavitary transducer immediately prior to the procedure. The probe was then withdrawn and the provider who did the US also performed the needle aspiration. The LM was performed using visual landmarks in a superior to inferior approach until pus was obtained or at least two sticks were performed. Anesthesia was standardized. Patients returned for follow-up in 2 days where a final diagnosis was rendered.

Results: There were 28 patients enrolled, with 14 in each arm. US established the correct diagnosis more often than LM [(100%, 95% confidence interval [CI] = 75% to 100% vs. 64%, 95% CI = 39% to 84%; p = 0.04)]. US also led to more successful aspiration of purulent material by the EP than LM in patients with PTA [(100%, 95% CI = 63% to 100% vs. 50%, 95% CI = 24% to 76%; p = 0.04)]. The ENT consult rate was 7% (95% CI = 0% to 34%) for US versus 50% (95% CI = 27% to 73%) for LM (p = 0.03). The CT usage rate was 0% for US versus 35% for LM (p = 0.04).

Conclusions: An initial intraoral US performed by EPs can reliably diagnose PTC and PTA. Additionally, using intraoral US to assist in the drainage of PTAs with needle aspiration leads to greater success compared to the traditional method of LM relying on physical exam alone.

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Peritonsillar abscess (PTA) is the most common deep space infection of the head and neck presenting to the emergency department (ED), with an incidence of about 1 in 10,000.[1] Although commonly thought to be associated with tonsillitis, PTA may be more likely caused by inflammation of the minor salivary glands (Weber's glands), which lie superior to the tonsils.[2,3] Smoking and periodontal disease are also believed to be risk factors for PTA.[4,5]

Historically, clinicians have relied on physical characteristics such as peritonsillar swelling and uvular

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deviation to make the diagnosis of PTA. However, physical examination has been shown to have only around 75% sensitivity and 50% specificity.[6] Therefore, emergency physicians (EPs) have begun to use intraoral ultrasound (US) as a way to improve diagnostic and procedural success. Early studies suggested intraoral US to be accurate in diagnosing PTA and assisting in its successful drainage.[7,8] Despite its growing use, this is the first comparative trial of intraoral US to diagnose and guide drainage of a PTA versus traditional landmark-based methods of inspection and needle aspiration by EPs.

The primary objective of this study was to compare the diagnostic accuracy of EPs for detecting PTA or peritonsillar cellulitis (PTC) using either intraoral US or initial needle aspiration after visual inspection (the landmark technique [LM]). Secondary objectives included the successful aspiration of purulent material in those patients with a PTA in each arm, the use of computed tomography (CT) scanning in each arm, and the otolaryngology (ENT) consultation rate in each arm.

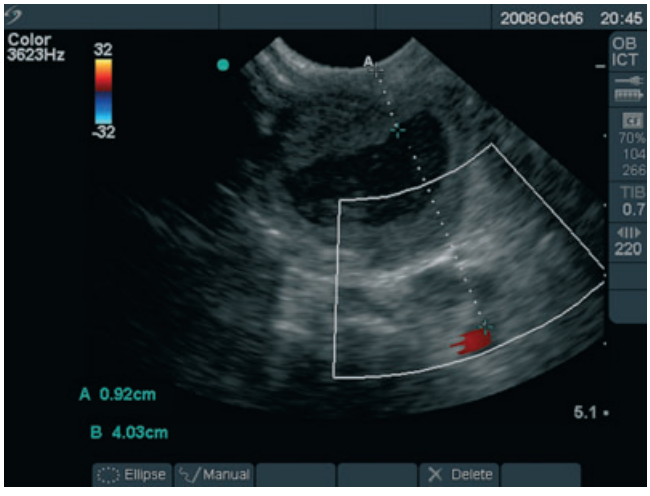

Figure 1. Intraoral US image in the transverse plane of a left PTA with the distance to the front of the abscess cavity (A) and the distance to the carotid artery (B) marked. PTA = peritonsillar abscess; US = ultrasound.

METHODS

Study Design

This was a prospective, randomized, controlled clinical trial. The study was approved by the university's institutional review board and patients gave written consent before they were enrolled in the study.

Study Setting and Population

We included a convenience sample of adult patients who presented to a single, large, urban university hospital between October 2008 and December 2010. Patients were enrolled when study investigators were available to obtain consent. After consent was obtained, patients were randomized to either arm by simple randomization using an Internet-based program with a concealed allocation schedule.

Patients were enrolled if they presented with a constellation of signs and symptoms that, in the judgment of the treating attending EP, represented a PTA, and that physician was ready to perform a needle aspiration of the PTA. Additional inclusion criteria included age >18 years and the ability to give consent. Exclusion criteria were patients who were clinically unstable due to airway or hemodynamic compromise.

Study Protocol

All patients were enrolled by the attending physician and the procedure was performed by either a second- or third-year emergency medicine resident under the supervision of the attending EP. All attending physicians were credentialed for US-guided procedures. All patients received a 0.5-second spray of topical anesthetic (14% benzocaine, 2% Butamben, 2% tetracaine) to the posterior pharynx. Additional anesthesia was used by infiltrating 0.5 mL of 1% lidocaine to the posterior pharynx directly over the area to be aspirated.

Patients in the LM arm then had needle aspiration attempted according to an established method.[9] If the initial aspiration was unsuccessful, one to two additional attempts were made. If all attempts were unsuccessful, clinical care proceeded at the discretion of the treating attending physician.

Patients in the US arm underwent EP-performed intraoral US using an 8–5 MHz intracavitary transducer using a SonoSite Micromaxx system (SonoSite, Bothell, WA). All treating clinicians had met or exceeded the American College of Emergency Physicians guidelines for training in emergency US.[10] An abscess was identified as a distinct anechoic area or hypoechoic area in the posterior pharynx in the area of swelling. The carotid artery was identified using color flow Doppler. Due to spatial concerns because of patients with mild trismus, all US studies were static. First the US was performed, then the probe was withdrawn and needle aspiration was attempted. The probe was held in the transverse position by the clinician who would also perform the needle aspiration to enhance stereotactic recall. The center of the abscess was identified by sweeping the probe in a cephalad to caudad manner. The distance to the front of the abscess and distance to the carotid were measured (Figure 1). The clinician then used visual estimation to approximate abscess volume prior to aspiration. Aspiration was then attempted using an 18-gauge needle attached to a 10-mL syringe. Two additional aspiration attempts were allowed if the first was not judged to have been successful. If no abscess on US was identified, no attempts at aspiration were made. In that case, and in the cases of unsuccessful aspiration, clinical care proceeded at the discretion of the treating physician.

All patients were instructed to follow up in the ED in 2 calendar days. At that visit, clinical resolution was judged by assessing for the constellation of signs or symptoms of PTA. The final diagnosis from that visit became the ''criterion standard'' final diagnosis.

Outcome Measures

The primary outcome was successful diagnosis. Since all patients in the LM arm underwent needle aspiration,

successful aspiration by the EP was recorded as PTA and unsuccessful aspiration by the EP was recorded as PTC. In the US arm, the results of the US alone determined the initial diagnosis. The final diagnosis was the diagnosis made by the attending physician after discharge from the hospital on the follow-up visit in 2 days. That physician had all available data to make the final diagnosis. The secondary outcome was successful aspiration of purulent material from patients whose final diagnosis was PTA. Other secondary outcomes included the frequency of CT scanning and ENT consultation in each arm.

Data Analysis

The sample size calculation was based on a power of 80%, with an estimated difference of 45% based on previous data from our institution.[11] Using this, we estimated that we would need to enroll 14 patients in each arm. Data are presented as means or proportions with 95% confidence intervals (CIs). Success rate comparisons between groups were analyzed with Fisher's exact method of summing small p-values. Measured data were compared with t-tests after assessment for normality. Differences in length of stay (LOS) times were compared using Student's t-test. Differences in distance data were compared with the Mann-Whitney method. A p-value of 0.05 was considered significant. All analyses were performed using MedCalc (version 9.3, Mariakerke, Belgium).

RESULTS

There were 28 patients enrolled with 14 in each arm (see Figure 2). There were no differences between treatment arms with respect to sex, age, or ED LOS (Table 1). There were eight PTA and six PTC in the US arm and 10 PTA and four PTC in the landmark arm, based on the final diagnosis. The diagnostic accuracy for US was 100% (95% CI = 75% to 100%; eight of eight PTA and six of six PTC) versus 64% (95% CI = 39% to 84%; 5 of 10 PTA and four of four PTC) for LM; p = 0.04 (likelihood ratio [LR] = 2.8, 95% CI = 1.39 to 5.65). US led to more successful aspiration of purulent material by the EP than LM in patients with PTA (100%, interquartile range [IQR] = 63% to 100% vs. 50%, IQR = 24% to 76%; p = 0.04) with a LR 2.0 (95% CI = 1.08 to 3.71). The ENT consult rate was 7% (IQR = 0% to 34%) for US versus 50% (IQR = 27% to 73%) for LM (p = 0.03). The CT usage rate was 0% for US versus 35% for LM (p = 0.04; Table 2).

No resident in either arm had performed greater than 10 PTA aspirations. Although an attending physician was always present to assist, a study author was the assisting attending physician in 6 of 14 in the US arm and 5 of 14 in the LM arm.

There was one immediate complication in the US group. Following topical anesthetic spray, US showed no abscess. The patient was then noted to have cyanosis although he remained asymptomatic. Despite an elevated methemoglobin level, no intervention was undertaken. The patient was discharged and had no sequela on follow-up with resolved pharyngeal symptoms. There were no incidences of carotid artery puncture. The average number of needle punctures was 1.4 in the US group and 2.4 for LM.

One patient in the LM arm had evidence of increased PTA on follow-up 2 days later, despite initial successful aspiration by the consultant ENT after failure by the EP on first visit and subsequent CT scan showing abscess. The patient was taken to the operating room where the abscess was incised and drained of additional purulent material. Chart abstraction showed clinical resolution on follow-up 1 week later. One patient in the US arm also had evidence of increased PTA on follow-up. After initial successful aspiration of 8 mL by the EP on the first visit, an additional 10 mL of purulent material was removed by needle aspiration on the return visit 2 days later. Chart abstraction also showed clinical resolution on ENT follow-up 1 week later. Chart abstraction was done at the conclusion of the study by the study authors for

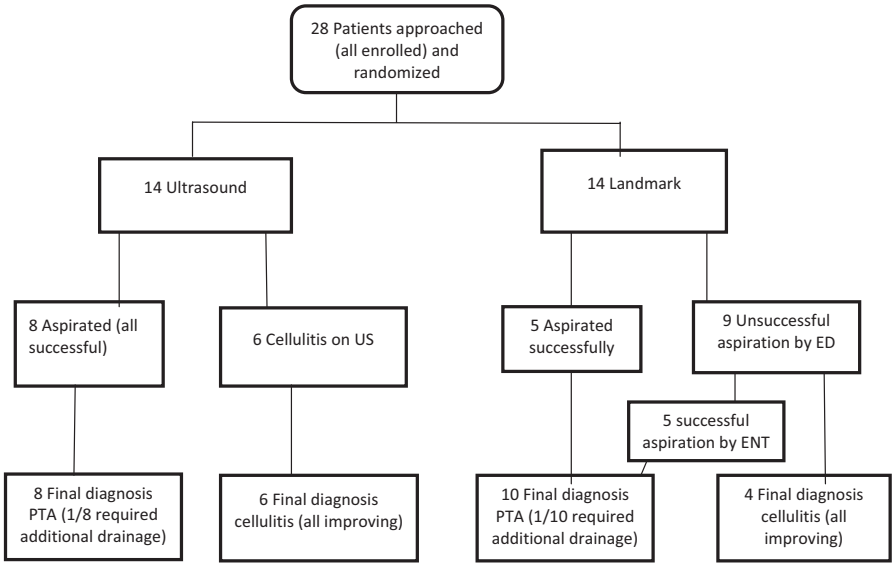

Figure 2. Patient flow chart. ENT = otolaryngology; PTA = peritonsillar abscess; US = ultrasound.

Table 1
Patient Characteristics

Characteristic	US, n = 14 (or 8 for distances)	Landmark, n = 14
Male	50%	50%
Age (yr)	26 (19–44)	28 (19–50)
ED LOS (minutes)	176 (48–460)	242 (56–450)
Distance to front of abscess (cm)	0.90 (0.43–1.49)	
Distance to carotid artery (cm)	3.63 (3.08–4.20)	

Data are reported as mean (range).
LOS = length of stay; US = ultrasound.

Table 2
Patient Outcomes by Treatment Assignment

Outcome	US (95% CI)	Landmark (95% CI)	p-value
Successful drainage by EP	100 (63–100)	50 (24–76)	0.04
Diagnostic accuracy	100 (75–100)	64 (39–84)	0.04
ENT consult rate	7 (1–34)	50 (27–73)	0.03
CT usage	0 (0–25)	35 (16–61)	0.04

Values are reported as percentages.
ENT = otolaryngology; US = ultrasound.

all patients to look for delayed complications or recurrence, but no other cases were identified.

All patients were treated with oral antibiotics and all were compliant at follow-up 2 days later. Clindamycin was chosen by 13 of 14 providers in the LM arm and 11 of 14 in the US arm. Both of the above failures of needle aspiration were placed on clindamycin. Three additional patients were placed on penicillin and one on amoxicillin.

DISCUSSION

Our study showed that intraoral US can reliably distinguish between PTA and PTC and guide the drainage of a PTA when present. An interesting finding of our study was the relatively high incidence of PTC (36%). Although similar to previously published rates of 20% to 30%, we thought our study design, which required needle aspiration in the LM arm, would tend to minimize the cases of PTC as only the most clinically suspicious cases of PTA would be enrolled.[6,8] Viewing our results from another perspective, 64% of the patients in the LM group had unsuccessful needle aspiration by the EP versus 0% in the US group. If further studies continue to support the high diagnostic accuracy of intraoral US for PTA and PTC, then reducing the number of unnecessary needle aspiration attempts in patients suspected of having a PTA may be the most important finding from our study.

For the LM group, we chose to use the result of the EP-performed aspiration to compare to the final diagnosis as the way to measure the diagnostic accuracy of this combined approach. Since enrollment criteria included the attending physician's judgment that a PTA was present based on history and exam, we thought that this best represented some clinicians' practice, where combined with negative aspiration attempts, the diagnosis of PTC would be made. Obviously, not all EPs would practice in this way. In our study, this approach alone was not used, as every patient with a negative aspiration then had either an ENT consultation or a CT scan. However, for studying the EP with needle aspiration technique alone versus the EP with US and needle aspiration technique, the reported results hold true. We feel that this information will be useful to the practicing EP. If we chose to compare intraoral US versus a combination of EP aspiration attempts, CT scanning, and ENT consultation aspiration attempts, we would have found no difference between the groups, as all would have been 100% successful at diagnosing both PTA and PTC. A much larger trial may be necessary to attempt to show differences in those two methods. Although previous studies have shown that EPs could successfully diagnose PTA with intraoral US, we believe that this is the first prospective, comparative trial.[7,8]

Ultrasound also led to more successful aspiration by EPs of PTA when present. The treatment of PTA is thought to be equally efficacious when the initial treatment is either needle aspiration or incision and drainage.[1,12] Since needle aspiration leads to less bleeding and pain, it was chosen for this study. We included infiltration of local anesthetic as well as topical, as this has been shown to increase patient comfort with the procedure.[13] Although all abscesses in the LM arm were successfully drained by needle aspiration by either the EP or the ENT consult, the 50% success rate for just the EP is similar to previous data from our institution.[11] There are no published data on how frequently EPs consult specialists to perform this task versus perform it themselves or how successful they are. All patients successfully drained by ENT after initial failure by EP had a CT scan performed prior to the ENT attempt. Since all ENT attempts were done by second-year residents using the same needle aspiration technique, our results probably reflect the usefulness of any imaging in guiding the drainage of a PTA. However, lack of familiarity with the technique or fear of complications may prevent successful aspiration. Although there are no published reports of carotid artery puncture during PTA aspiration attempts, anecdotal reports exist, and known cases of carotid pseudoaneurysm masquerading as PTA do lend caution to those attempting the procedure.[14] We have included the measured distance from the posterior pharynx to the anterior wall of the carotid (Table 1) and, in every case, the distance was greater than 3 cm.

All studies were performed by residents under the direct supervision of the attending. The residents' familiarity with US and lack of experience with PTA may have led to an overstatement of their success with US and an understatement of the success with LM compared to the average EP. Nevertheless, with US guidance, PTA was successfully drained in 100% of the patients in this study, which is similar to previous

studies.[7,8] Intraoral US seems to be a useful tool for EPs to successfully drain a PTA.

One patient in each arm had recurrence of PTA on their follow-up visit, which necessitated further drainage. This is similar to previously published reports of the success of a single aspiration procedure.[11] Both recurrences were treated with the same antibiotic, clindamycin. Despite the high reported rate of penicillin-resistant microbes in PTA, several studies report penicillin to still be effective in its management.[15,16] The two cases of PTA in the US group and the one case of PTC in the LM group treated with penicillin all had good clinical outcomes.

Patients in the US arm also had significantly reduced consultation rates and imaging with CT. These factors are probably related. The consultations were done after the aspiration attempts failed. Since the initial aspiration failed, the consultants ordered an imaging study to determine if failure was due to technical factors or due to the diagnosis of PTC. The one ENT consultation in the US arm was after successful aspiration by the EP. The ENT consultant agreed with the treatment decisions and did not alter care. CT has been shown to be similar to intraoral US in the diagnosis of PTA when performed by radiologists.[6] Our study showed US to be very accurate in diagnosing PTA and PTC without the need for CT imaging and the accompanying concerns about cost and radiation.

LIMITATIONS

This study suffers from the limitations of convenience sampling. Also, since enrollment occurred when study authors were available, there may have been an unintentional effect leading to greater success in the US arm as treating clinicians may have felt the desire to demonstrate greater proficiency with that technique if study investigators were present.

The treating clinicians were residents who may have more US knowledge compared to most practicing EPs and also less experience with landmark-based PTA drainage. Although the range of attending physician experience with both techniques varied, the residents actually performed the procedure and none had done more than 10 previous PTA aspirations, although all had done >150 total US scans. This could lead to bias toward success in the US arm and lack of success in the LM arm and may limit general applicability to a practicing EP. Our study was powered to detect the large discrepancy in success between the two arms found in our retrospective study. In more experienced physicians, a larger study may be necessary to show if a significant difference would still exist in those with more experience using the LM.

Using clinical judgment as the criterion standard for the final diagnosis on the second visit instead of CT imaging may have led to an overstatement of the occurrence of PTC, as small abscesses not seen on US may have resolved without drainage. Because the follow-up physician was not blinded to the previous results, a negative US may have swayed them to continue the diagnosis of PTC. Also, a 2-day follow-up may not be sufficient to detect worsening of these potential small abscesses, which may also lead to overstatement of the diagnostic accuracy of US.

CONCLUSIONS

An initial intraoral ultrasound performed by EPs can reliably diagnose peritonsillar cellulitis and peritonsillar abscess. Additionally, using intraoral ultrasound to assist in the drainage of peritonsillar abscesses with needle aspiration leads to greater success compared to the traditional method of landmark technique relying on physical exam alone. If these results are confirmed by future larger studies, EPs should consider using intraoral ultrasound on all patients with suspected peritonsillar abscess.

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