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ORIGINAL CONTRIBUTION

Ultrasound-versus landmark-guided medium-sized joint arthrocentesis: A randomized clinical trial

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Abstract

Objectives: Arthrocentesis is commonly performed in the emergency department, but success rates vary based on location. Presently, there is a paucity of data assessing the utility of ultrasound-guided (USG) medium-sized joint arthrocentesis. The objective of this study was to compare the success of USG and landmark-guided (LMG) medium-sized joint arthrocentesis.

Methods: This was a single-center, prospective, randomized clinical trial (NCT03327584) of a convenience sample of adult patients who presented to an urban, university hospital with > 105,000 visits annually. Patients with a suspected medium-sized joint effusion (defined as elbow, wrist, or ankle) undergoing arthrocentesis were randomized into LMG or USG using the GE Logiq e linear transducer (4–10 MHz). The following patients were excluded: on anticoagulation, with soft tissue infection overlying the joint, or involving an artificial joint. Statistical analysis included the Fisher exact, Mann-Whitney U-test, and t-test.

Results: Overall, 44 patients were enrolled with 23 patients randomized into the LMG group and 21 patients into the USG arm. USG was significantly better than LMG with an overall success of 94.1% versus 60% for LMG (difference = 34.1%, 95% confidence interval [CI] = 4.90 to 58.83). USG first-pass success was 82.4% versus 46.7% for LMG (difference = 35.7%, 95% CI = 2.76 to 60.37) and a mean of 1.35 attempts versus 2.00 for LMG (difference = 0.65, 95% CI = 0.005 to 1.296). Of the 14 LMG failures, eight had no effusion present on USG crossover. Four patients in the USG group had no effusion present.

Conclusions: Ultrasound guidance improved first-pass and overall successful arthrocentesis of medium-sized joint effusions.

KEYWORDS
arthrocentesis, point-of-care ultrasound

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INTRODUCTION

Arthrocentesis is a fundamental skill of emergency physicians (EPs). According to the Healthcare Cost and Utilization Project unweighted Nationwide Emergency Department Sample (NEDS) over 647,000 joint aspirations were performed in emergency departments (EDs) nationwide in 2017.[1] Arthrocentesis is utilized both diagnostically and therapeutically, but it is not without its potential complications, including infection, neurovascular injury, hemarthrosis, and pain.[2–5] Traditional teaching relies on anatomic landmarks to guide arthrocentesis (LMG). However, physical examination has poor diagnostic sensitivity for detecting joint effusions.[6,7] Furthermore, patient body habitus and joint size significantly limit the accuracy of anatomic landmarks for arthrocentesis.

Point-of-care ultrasound (POCUS) has become more prevalent in numerous fields of medicine. Adhikari and Blaivas[8] demonstrated that POCUS changed EP management in 65% of cases when evaluating musculoskeletal pathology. Moreover, Wiler et al.[9] showed enhanced provider confidence with ultrasound-guided (USG) knee arthrocentesis versus LMG, while reducing procedural pain and yielding greater volumes of aspirate. Rheumatology literature comparing LMG to USG arthrocentesis exhibited similar results, including enhanced success rates with reduced pain, failure rates, and complications.[10–12] Moreover, numerous rheumatologic studies have validated the superiority of USG needle placement into joints compared not only to LMG but to fluoroscopy as well.[13–22]

To our knowledge, only one emergency medicine study, involving cadavers, has assessed the utility of USG medium-sized joint arthrocentesis by emergency medicine physicians.[23] The primary objective of this study is to compare USG and LMG arthrocentesis by emergency medicine residents with respect to overall success. Secondary analysis includes first-pass success, number of attempts, and complications.

METHODS

Study design

This was an institutional review board–approved single-center, prospective, randomized clinical trial (NCT03327584) with parallel assignment and an allocation ratio of 1:1. We followed the CONSORT guidelines and checklists for clinical trials. No funding was provided for this study. Study inclusions and primary outcome differ from those originally listed on clinicaltrials.gov. Prior to study initiation, the study investigators excluded small joints, defined as metacarpal and metatarsal joints, given their infrequent occurrence, and changed the primary outcome to overall success given that this endpoint is more reflective of clinical practice than first-pass success.

Study setting and population

We included a convenience sample of patients ≥ 18 years old, who presented to an urban, academic, Level I ED between January 1, 2018, and March 31, 2021, and who required an arthrocentesis of a medium-sized joint. Patients were enrolled when study investigators were available to obtain written informed consent from the patient. All our emergency medicine physicians are credentialed in the core POCUS applications as defined by the American College of Emergency Physicians (ACEP).[24]

All English- and Spanish-speaking patients requiring an arthrocentesis of a suspected medium-sized joint effusion were eligible to be enrolled. The presence of a suspected effusion was based on physical examination alone. No plain films were done. The authors defined medium-sized joint as elbow, wrist, and ankle. The following patients were excluded: unable to consent, on anticoagulation (not including antiplatelet medications), had a soft tissue infection overlying the joint, or involving an artificial joint. Indications for arthrocentesis included therapeutic and diagnostic evaluation of a suspected medium-sized joint effusion in the judgment of the treating attending emergency physician.

Study protocol

Study investigators utilized permuted-block randomization with an allocation ratio of 1:1. Allocation concealment included sequentially numbered, opaque, sealed envelopes. Upon enrollment, the patient was randomized into USG or LMG arthrocentesis. Blinded study investigators selected a sealed envelope containing study materials and prerandomized selection into USG versus LMG using Research Randomizer (Version 4.0).[25] Utilizing sterile technique, a single operator PGY-1 to PGY–3 emergency medicine resident performed the arthrocentesis with a BD Precision Glide 21-gauge 1½-in. needle (Becton, Dickinson and Company), oriented in the longitudinal plan, using a GE Logiq e wide band 4- to 12-MHz linear array transducer. Utilizing dynamic needle-tip guidance, a single operator handled the transducer and manipulated the catheter.[26,27] The landmark techniques, previously described by Springer and Pennington,[28] were utilized to aspirate each joint. A quantity of 1–3 mL of 1% lidocaine with epinephrine was used as local cutaneous anesthetic.

Prior to starting their internship, our emergency medicine residents participate in an introductory 4-hr USG procedural course taught by our emergency ultrasound faculty. Additionally, each resident completes a 4-week emergency ultrasound rotation during their internship in accordance with Accreditation Council for Graduate Medical Education (ACGME) and ACEP guidelines.[24,29] No additional training was provided to the residents prior to their study participation.

An emergency medicine attending supervised the resident performing the arthrocentesis. The supervising attending did not manipulate the transducer or needle during the procedure. At no point did the supervisor provide tactile assistance. If unable to aspirate the joint following three attempts, a more senior emergency medicine resident or attending completed the arthrocentesis.

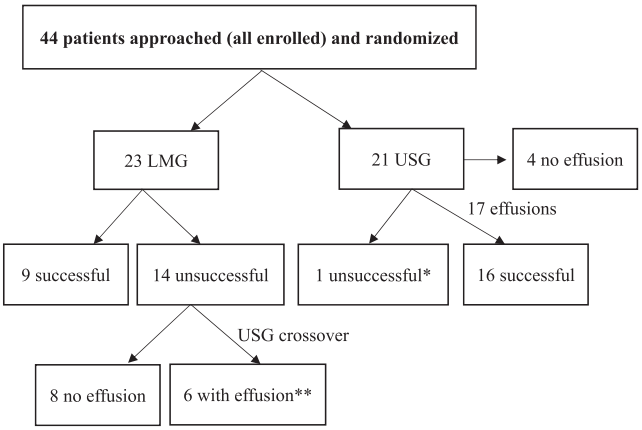

FIGURE 1 Patient flow chart

Measurements

An independent department research assistant, blinded to the study's objectives, assessed the operator with respect to first-pass success, number of attempts (limited to three), complications, and need to crossover to the alternative method. Attempts were predefined as changing direction or withdrawing the needle to puncture the skin again. The presence of an effusion was predefined as aspiration of synovial fluid or the sonographic presence of joint fluid.

Predefined complications included hematoma/hemarthrosis, infection, and neurovascular injury. Complications were recorded by the independent observer at the time of the procedure. Using the electronic medical record, Epic, study investigators performed chart abstraction on all patients 7 days after the initial ED presentation to identify any patients who reported complications. Epic allows providers to query participating local health systems to share medical records. The primary endpoint was overall success of needle aspiration. Secondary endpoints were first-pass success, mean number of attempts, and complications.

Data analysis

Based on an alpha value of 0.05 and beta of 0.80, our sample size calculation of 14 patients, with confirmed effusions on ultrasound or aspiration of synovial fluid, randomized to each arm was based on previous data demonstrating an estimated difference in success of 45% between USG and LMG arthrocentesis.[10,11,23,30] Data are presented as medians or proportions with 95% confidence intervals (CIs) utilizing the Fisher exact test. Continuous data were compared with the Mann-Whitney U-test. Mean attempts are compared between USG and LMG using the t-test. Authors conducted both intention-to-treat and preprotocol analyses. All analyses were performed using MedCalc (Version 19.1.6).

RESULTS

Overall, 44 patients were enrolled with 23 patients randomized into the LMG group and 21 patients into the USG arm (Figure 1). Patient characteristics, resident experience, joints aspirated, and indications for arthrocentesis were similar for both groups (Table 1). Seventeen patients in the USG group had an effusion present. Four patients in the USG arm did not have an effusion on ultrasound, so no aspiration was attempted. All 23 patients randomized into the LMG group had needle aspiration attempted. Nine were successfully aspirated. The remaining 14 required crossover to USG. Of those, eight had no effusion. Six patients had an effusion visualized on ultrasound. Therefore, 17 patients comprised the USG study group and 15 in the LMG study arm meeting our power analysis requirement.

TABLE 1 Patient characteristics

Characteristic	USG ($n = 21$)	LMG ($n = 23$)
Age (years), median (IQR)	58 (23–89)	59 (25–89)
Sex, *n* (%)		
Female	38%	35%
Male	62%	65%
BMI, median (IQR)	28.2 (22.5–40.3)	30.6 (22.8–51.4)
Resident experience (number of prior medium joint arthrocentesis), median (IQR)	2.80 (0–6) 14 different residents	2.71 (0–6) 18 different residents
Number of joints aspirated		
Wrist	11	12
Ankle	7	9
Elbow	3	2
Number of arthrocentesis indications		
Hemarthrosis	3	0
Crystal arthropathy	8	4
Septic effusion	10	18
Therapeutic	0	1

Abbreviations: IQR, Interquartile range; LMG, landmark guidance; USG, ultrasound guidance.

USG had an overall success of 94.1% versus 60% for LMG (difference = 34%, 95% CI = 4.90 to 58.83), a first-pass success of 82.4% versus 46.7% for LMG (difference = 35.7%, 95% CI = 2.76 to 60.37), and a mean of 1.35 attempts versus 2.00 for LMG (difference = 0.65, 95% CI = 0.005 to 1.295). No complications were reported. Table 2 summarizes the results.

If we included an intention-to-treat analysis of all 44 patients, USG had successful aspiration of 85% and LMG 39.1% (difference = 46%, 95% CI = 16.91 to 65.56). One patient in the LMG had a successful arthrocentesis with USG crossover. Notably, physical examination had an accuracy of only 72.7% (95% CI = 57.21 to 85.04).

DISCUSSION

Current data confirm the poor diagnostic accuracy of physical examination for detecting joint effusions. Two rheumatology studies have demonstrated sensitivities of 59% and 63% for the physical examination diagnosis of knee effusions.[6,7] Adhikari and Blaivas[8] showed

TABLE 2 Patient outcomes by treatment assignment

Outcomes	USG	LMG	Difference (95% CI)
Overall success	94.1%	60%	34.1 (4.90–58.83)
First-pass success	82.4%	46.7%	35.7 (2.76–60.37)
Number of attempts, mean	1.35	2.00	0.65 (0.005–1.296)

Abbreviations: LMG, landmark guidance; USG, ultrasound guidance.

that EPs missed effusions in 50% of cases. Our study depicted similar results with an accuracy of 73% for the physical examination identification of medium-sized joint effusions. Furthermore, eight patients in the LMG had an unsuccessful arthrocentesis performed, and then postprocedural sonography confirmed the absence of an effusion. In our study population, an ultrasound-first approach would have reduced unnecessary aspirations by 35%.

Sonography can detect as little as 0.5–2 mL of synovial fluid.[31–34] An abstract by Tayal et al.[30] indicated that USG improves aspiration success with fewer attempts than LMG for peripheral nonknee arthrocentesis. Likewise, Berona et al.[23] demonstrated improved aspiration success and provider confidence with USG, while minimizing attempts and time to completion for aspiration of hip, wrist, and ankle effusions in cadaveric models. Similarly, an abstract by Gordon et al.[34] showed less time for successful aspiration of elbow, wrist, and ankle effusions in cadaveric models by three separate EPs.

Ours is the first published study comparing ultrasound and landmark guidance of medium-sized joint arthrocentesis in ED patients to the best of our knowledge. In our study, 24 different emergency medicine residents, with minimal experience performing medium-sized joint arthrocentesis, aspirated the joint. Our rationale was to compare each technique without the bias of significant experience with either method. Our results suggest that USG is the superior approach to medium-sized joint arthrocentesis in an academic residency resulting in greater overall successful aspiration. In addition, using an ultrasound-first approach may avoid unnecessary aspiration attempts in patients with no effusion although our study did not specifically address this result. Previous emergency medicine literature of knee arthrocentesis did not show a difference in success between LMG and USG arms.[9] For smaller joints, such as those studied in this article, successful aspiration is more difficult, allowing the benefits of ultrasound guidance to improve success. These data can be extrapolated to the wider emergency medicine community as the prevalence of ultrasound competency increases in practicing emergency medicine physicians.

LIMITATIONS

This study suffers from the limitations of a single-center study and the convenience sampling of the patients resulting in a selection bias as well as a smaller sample size, which was statistically significant, nonetheless. The wide CIs limit the validity of our results. No immediate complications were reported, and electronic medical review limits the accuracy of identifying delayed complications in either group.

In our study, 52.3% of joints included were wrists and 36.4% were ankles, which may limit the generalizability of our results to all medium sized joints. Furthermore, we did not measure the size of the effusion, which may have differed between groups.

The most significant limitation was our definition regarding the presence of a joint effusion. Specifically, we defined it as aspiration of synovial fluid or the sonographic appearance of fluid in the joint. It was impractical to utilize advanced imaging, such as MRI, to confirm the presence or absence of an effusion.

Our use of USG as a rescue method is a limitation as well. It is possible that more patients in the LMG arm may have had an effusion that was not detected on ultrasound, and the 40% failure rate may not have been accurate. It is also possible that the four patients in the USG arm who did not have an effusion on ultrasound had one and therefore should have had needle aspiration attempted. However, it is more likely that the small sample size led to an unequal distribution of patients without an actual effusion in the LMG arm. This may have led to a bias toward ultrasound success and LMG failure.

Additionally, we did not account for any specific verbal guidance provided by the supervising attending, i.e., needle or probe manipulation, ultrasound setting adjustments, etc. Nonetheless, no supervising attending provided tactile assistance with either the transducer or catheter.

Similarly, we did not account for prior POCUS and procedural proficiency for each resident. Those with more POCUS procedural skill in general may have caused a bias toward ultrasound success. Nonetheless, the mean number of prior medium-sized joint arthrocentesis was less than three in both groups.

The study was conducted by faculty in the division of emergency ultrasound. This was known by the residents participating in the study, which may have led to a bias toward ultrasound success as well. As mentioned previously, another significant limitation was the employment of ultrasound as the rescue method when landmark guidance failed. This may have led to a bias toward ultrasound success if the resident perceived the ultrasound to be superior.

Finally, our ED is not representative of the broader emergency medicine community. We have an active ultrasound division with numerous faculty and fellows. All ED attendings are credentialed in POCUS. In our department, residents are the treating clinicians who typically have more POCUS experience compared to most practicing EPs.

CONCLUSIONS

In summary, ultrasound guidance improved overall success of medium-sized joint arthrocentesis. Future larger, multicenter studies are required to validate these findings.

CONFLICT OF INTEREST

The authors have no potential conflicts to disclose.

AUTHOR CONTRIBUTIONS

Ryan C. Gibbons: study concept and design, data acquisition, analysis and interpretation, manuscript draft. Jessica Genninger and

Allison Zanaboni: data acquisition, manuscript revision. Thomas G. Costantino: study concept and design, data analysis and interpretation, manuscript revision.

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REFERENCES

1. Nationwide Emergency Department Sample. HCUP Summary Statistics Report: NEDS 2017 ED File. 2017. Accessed May 1, 2020. https://www.hcup-us.ahrq.gov/db/nation/neds/stats/NEDS_2017_ED_MaskedStats.PDF
2. Sanford SO. Arthrocentesis. In: Roberts J, ed. *Roberts and Hedges' Clinical Procedures in Emergency Medicine*. 6th ed. Elsevier; 2018:1075-1094.
3. Ahmed I, Gertner E. Safety of arthrocentesis and joint injection in patients receiving anticoagulation at therapeutic levels. *Am J Med*. 2012;125:265-269.
4. Carpenter CR, Schuur JD, Everett WW, Pines JM. Evidence-based diagnostics: adult septic arthritis. *Acad Emerg Med*. 2011;18:781-796.
5. Dooley DP. Aspiration of the possibly septic joint through potential cellulitis: just do it! *J Emerg Med*. 2002;23:210.
6. Kane D, Balint PV, Sturrock RD. Ultrasonography is superior to clinical examination in the detection and localization of knee joint effusion in rheumatoid arthritis. *J Rheumatol*. 2003;30:966-971.
7. Chávez-López MA, Naredo E, Acebes-Cachafeiro JC, et al. Diagnostic accuracy of physical examination of the knee in rheumatoid arthritis: clinical and ultrasonographic study of joint effusion and Baker's cyst. *Rheumatol Clin*. 2007;3:98-100.
8. Adhikari S, Blaivas M. Utility of bedside sonography to distinguish soft tissue abnormalities from joint effusions in the emergency department. *J Ultrasound Med*. 2010;29(4):519-526.
9. Wiler JL, Costantino TG, Filippone L, Satz W. Comparison of ultrasound-guided and standard landmark techniques for knee arthrocentesis. *J Emerg Med*. 2010;39(1):76-82.
10. Raza K, Lee CY, Pilling D, et al. Ultrasound guidance allows accurate needle placement and aspiration from small joints in patients with early inflammatory arthritis. *Rheumatology*. 2003;42:976-979.
11. Balint PV, Kane D, Hunter J, McInnes IB, Field M, Sturrock RD. Ultrasound guided versus conventional joint and soft tissue fluid aspiration in rheumatology practice: a pilot study. *J Rheumatol*. 2002;29(10):2209-2213.
12. Sibbitt WL, Kettwich LG, Band PA, et al. Does ultrasound guidance improve the outcomes of arthrocentesis and corticosteroid injection of the knee? *Scand J Rheumatol*. 2012;41:66-72.
13. Gilliland CA, Salazar LD, Borchers JR. Ultrasound versus anatomic guidance for intra-articular and periarticular injection: a systematic review. *Phys Sports Med*. 2011;39:121-131.
14. Cunnington J, Marshall N, Hide G, et al. A randomized, double-blind, controlled study of ultrasound-guided corticosteroid injection into the joint of patients with inflammatory arthritis. *Arthritis Rheumatol*. 2010;62(7):1862-1869.
15. Berkoff DJ, Miller LE, Block JE. Clinical utility of ultrasound guidance for intra-articular knee injections: a review. *Clin Interv Aging*. 2012;7:89-95.
16. Bloom JE, Rischin A, Johnston RV, Bunchbiner R. Image-guided versus blind glucocorticoid injection for shoulder pain. *Cochrane Database Syst Rev*. 2012;(8):CD009147. doi: 10.1002/14651858.CD009147.pub2
17. Patel DN, Nayyar S, Hasan S, Khatib O, Sidash S, Jazrawi LM. Comparison of ultrasound-guided versus blind glenohumeral injections: a cadaveric study. *J Shoulder Elbow Surg*. 2012;21:1664-1668.
18. Sabeti-Aschraf M, Lemmerhofer B, Lang S, et al. Ultrasound guidance improves the accuracy of the acromioclavicular joint infiltration: a prospective randomized study. *Knee Surg Sports Traumatol Arthrosc*. 2011;19:292-295.
19. Nam SH, Kim J, Lee JH, Ahn J, Kim YJ, Park Y. Palpation versus ultrasound-guided corticosteroid injections and short-term effect in the distal radioulnar joint disorder: a randomized, prospective single-blinded study. *Clin Rheumatol*. 2014;33:1807-1814.
20. Dubreuil M, Greger S, LaValley M, Cunnington J, Sibbitt WL Jr, Kissin EY. Improvement in wrist pain with ultrasound-guided glucocorticoid injections: a meta-analysis of individual patient data. *Semin Arthritis Rheumatol*. 2013;42:492-497.
21. Khosla S, Thiele R, Baumhauer JF. Ultrasound guidance for intra-articular injections of the foot and ankle. *Foot Ankle Int*. 2009;30:886-890.
22. Amber KT, Landy DC, Amber I, Knopf D, Guerra J. Comparing the accuracy of ultrasound versus fluoroscopy in glenohumeral injections: a systematic review and meta-analysis. *J Clin Ultrasound*. 2014;42:411-416.
23. Berona K, Abdi A, Menchine M, et al. Success of ultrasound-guided versus landmark-guided arthrocentesis of hip, ankle, and wrist in a cadaver model. *Am J Emerg Med*. 2017;35(2):240-244.
24. Ultrasound guidelines: emergency, point-of-care, and clinical ultrasound guidelines in medicine. American College of Emergency Physicians. 2008. Accessed May 1, 2021. https://www.acep.org/patient-care/policy-statements/ultrasound-guidelines-emergency-point-of--care-and-clinical-ultrasound-guidelines-in-medicine/
25. Urbaniak GC, Plous S. Research randomizer (version 4.0) [computer software]. Accessed January 1, 2017. http://www.randomizer.org/
26. Kiberenge RK, Ueda K, Rosauer B. Ultrasound-guided dynamic needle tip positioning technique versus palpation technique for radial arterial cannulation in adult surgical patients: a randomized controlled trial. *Anesth Analg*. 2018;126(1):120-126.
27. Takeshita J, Yoshida T, Nakajima Y, et al. Dynamic needle tip positioning for ultrasound-guided arterial catheterization in infants and small children with deep arteries: a randomized controlled trial. *J Cardiothorac Vasc Anesth*. 2019;33(7):1919-1925.
28. Springer BL, Pennington BM. Joint arthrocentesis in the emergency department. *Emerg Med Rep*. 2017;38(19).
29. Emergency medicine defined key index procedure minimums. Accreditation Council of Graduate Medical Education. 2017. Accessed May 1, 2021. https://www.acgme.org/Portals/0/PFAssets/ProgramResources/EM_Key_Index_Procedure_Minimums_103117.pdf?ver=2017-11-10-130003-693
30. Tayal VS, Pariyadath M, Norton J. Randomized controlled trial of ultrasound-guided peripheral non-knee arthrocentesis in the emergency department. *Acad Emerg Med*. 2006;13(5):S197.
31. Jacobson JA, Andresen R, Jaovisidha S, et al. Detection of ankle effusions: comparison study in cadavers using radiography, sonography, and MR imaging. *Am J Roentgenol*. 1998;170(5):1231-1238.
32. Marchal GJ, Van Holsbeeck MT, Raes M, et al. Transient synovitis of the hip in children: role of US. *Radiology*. 1987;162(3):825-828.
33. Ike RW, Somers EC, Arnold EL, Arnold WJ. Ultrasound of the knee during voluntary quadriceps contraction: a technique for detecting otherwise occult effusions. *Arthritis Care Res*. 2010;62:725-729.
34. Gordon R, Laravia L, Eric Z, Lyon M. A comparison of ultrasound-guided to landmark-guided arthrocentesis of ankle, elbow, and wrist. *Ann Emerg Med*. 2013;4(62):S34.

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