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Original Research

New Simplified Approach to Real-Time Ultrasound-Guided Musculoskeletal and Peripheral Nerve Injections under Non-Draping, Non-Sterile Glove-Wearing Conditions

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Abstract

Ultrasound-guided musculoskeletal and peripheral nerve block injections are safe and cost-effective procedures that have gained popularity in pain medicine and family practice alike. The traditional injection process includes the use of sterile draping, sterile covering of transducer, and sterile glove wearing which significantly limits its efficiency and efficacy. From June 11, 2014 to January 30, 2025, our senior author, DG, has performed 33,509 musculoskeletal and joint injections, as well as peripheral nerve hydrodissections and block injections using a novel real-time ultrasound-guided musculoskeletal and peripheral nerve injection approach. This approach is employed under a non-draping, non-sterile transducer covering, non-sterile glove use condition, relying solely on betadine or chlorhexidine for skin antisepsis. Skin antisepsis being the most critical measure in preventing infections. This new approach significantly reduces the average procedure duration and maintains at least an equivalent post-procedure infection rate when compared to traditional sterile technique. Data from these procedures were collected from retrospective medical records and of the procedures performed, there have been 0 post-procedure infections.

The aim of this article is to propose a simplified, real-time ultrasound-guided musculoskeletal and peripheral nerve injection approach under non-draping, non-sterile transducer covering, and non-sterile glove wearing conditions that maintains or improves upon the estimated incidence of post-procedure musculoskeletal infections using the traditional method. This new method that is supported by a sufficiently large patient set, significantly decreases procedure time and increases patient satisfaction.

Keywords: Ultrasound, Injection, Infection, Ultrasound guided injection

Introduction

The utility of real-time ultrasound-guidance in musculoskeletal injections has become clear. When paired with accurate interpretation of sonographic images, providers are able to perform musculoskeletal injections with greater accuracy and improved pain management, especially for intra-articular injections, when compared to landmark-guided techniques [1]. Because of this, more providers are administering real-time ultrasound-guided musculoskeletal and peripheral nerve block injections and these providers are performing more injections each year. Fortunately, real-time ultrasound-guided musculoskeletal and peripheral nerve block injections can be performed by primary care physicians as well as specialist providers and are considered relatively low-risk procedures. In a 2014 study, Intra-articular injections, for example, hold an estimated post-procedure infection rate of 4.6 per 100,000 cases [2].

Given the clear negative outcomes associated with post-procedure infections, evidence-based antiseptic techniques are essential in minimizing preventable microbial infection resulting from real-time ultrasound-guided musculoskeletal and peripheral nerve block injections. Current methods of site preparation vary among providers. However, many recommend the use of probe covers, sterile pads, probe covers, and a no-touch technique. Current guidelines emphasize providers should maintain high levels of sterility and strict adherence to aseptic techniques to minimize the risk of infection [3]. However, there is currently a paucity of data supporting the benefit of full sterile technique over sub-sterile precautions.

Moreover, the use of standard sterile preparations adds considerable time-cost and additional resource-burden to providing real-time ultrasound-guided injections [4–6]. Because of this, the current consensus of using standard sterile technique for direct ultrasound-guided injections reduces accessibility for many clinics and providers who may otherwise be capable of performing them. With the continual expansion of providers administering ultrasound-guided injections, it is essential to develop a standard antiseptic approach that both remains as accessible as possible while simultaneously minimizing adverse outcomes, such as the risk of post-injection musculoskeletal infection [6–8].

This article proposes a cost-effective, simplified antiseptic approach for performing real-time ultrasound-guided musculoskeletal and peripheral nerve block injections that also maintains minimal risk of complications including post-injection musculoskeletal infection when compared to standard sterile technique.

Patients and Methods

Data collection

In this case series, records of patients who underwent real-time ultrasound-guided musculoskeletal and peripheral nerve block injections performed by our senior author DG in clinic-based procedure rooms were retrospectively collected through an electronic medical record query after approval from Advocate Aurora Health Ethics Board and BayCare Clinic Board. Patients were queried for procedures performed from the years 2014 through 2025. All patients, regardless of treatment effectiveness, were included in the dataset, as the study aimed to evaluate whether sterility is necessary to prevent infection for musculoskeletal and peripheral nerve block injections. All patients were between the ages of 14 and 99. Patients were not excluded for comorbid conditions, such as obesity and diabetes mellitus. Of the patients included, 17,434 procedures were conducted on those with a BMI (Body Mass Index) greater than or equal to 30 at the time of the procedure. None of the patients had a pre-existing musculoskeletal infection. Each case represents one procedure. One or more procedures may be attributed to a single patient. A total of 33,509 procedures met the criteria for inclusion across 4,713 unique patients. Procedures were then sub-categorized by type and tabulated. Procedures not classified as real-time ultrasound-guided injections were excluded. The outcome of interest measured was musculoskeletal infection following procedure.

Description of injection approach

All subjects received therapeutic musculoskeletal or peripheral nerve hydrodissection and block injections under ultrasound guidance using our senior author DG's real-time ultrasound-guided musculoskeletal or peripheral nerve block injection approach. Verbal or informed consent was obtained prior to procedures. A medical assistant was present to assist with adjusting parameters of the ultrasound machine and to record the sonographic images during the procedure to optimize efficiency. However, it also works if providers want to control the machine themselves during the procedure. The protocol begins with the provider operating the ultrasound probe with non-sterile gel to locate target structures. The provider then marks the designated needle entry site as well as the probe placement site with a surgical skin marker. The designated needle entry site would generally be divided into two groups: *a*. should be at least 1-inch away from the proximal end of the probe with use of curvilinear or linear probe guidance for the large joints, medium joints, chest, back, buttock, abdominal wall, and some peripheral nerve injections; *b*. should be placed as far as possible from the proximal end of the probe with use of "hockey-stick" probe guidance for injections of small joints of the hand and feet (in-plane) or as far as possible from the side of the probe with use of "hockey-stick" probe guidance for injections of small joints of the hand and feet (off-plane). With use of curvilinear or linear probe guidance for large, median joints, chest, back, abdominal wall, and some peripheral nerve injections, the ultrasound transmission gel is then wiped away to keep the injection area dry. The provider then prepares the injection site with standard skin antisepsis using betadine or chlorhexidine gluconate covering a 12-cm radius surrounding the injection site; we cover the whole finger or toe and adjacent finger or toes surrounding the injection site with use of "hockey-stick" probe guidance for small joints of hand and feet injections. This step is critical, as effective skin antisepsis serves as the primary barrier against infection. For the case of group *a*, prior to injection, the distal portion of the needle is bent about 5 to 10 degrees according to the depth of the injection target using a large bore needle to allow the needle to be redirected inside the body without being completely retracted as necessary for deep injection. Additional retractions and re-injections increase the risk of musculoskeletal infection and should be avoided if possible. The provider will wipe the injection site with three sterile 70% isopropyl alcohol pads if using betadine. Ethyl-chloride spray is applied to the needle entry site to decrease pain sensation, the needle is then inserted into the designated injection needle entry site. Afterwards, the probe with a small amount of non-sterile gel is placed on the marked probe site. The proximal end of the probe remains away from the needle site as described above. The needle is then identified sonographically. The needle is advanced under real-time ultrasound guidance to the target. CF flow may be applied to confirm the vascular circulation during needle advancement intermittently on an as-needed basis. The contents of the prepared medication solution are injected at the target site while visualizing the course of the fluid. For peripheral nerve hydrodissection and block procedure, the needle is redirected around the nerve for hydrodissection maneuver to separate scarring tissue or fasciae soft tissue that cause the compression or entrapment of the nerve. For the case of group *b*, we use out-of-plane technique. All other processes of the procedure are similar between groups *a* and *b*. In addition, the needles we used according to different injections include: 30-gauge 1-inch, 27-gauge 1.5-inch, 22-gauge 1.5-inch, 22-gauge 3.5-inch, and 22-gauge 5-inch. For the aspiration procedure, we use an 18-gauge 1.5-inch, or 3.5-inch needle accordingly. When complete, the needle is retracted and discarded, the injection site is again wiped with one 70% isopropyl alcohol wipe, and a small bandage is used as a barrier to cover the injection site. Pressure is applied over the injection region for 1-3 minutes by the assistant. The average total procedure time for the provider is 10 minutes for each patient.

Results

From June 11, 2014 to January 30, 2025 our senior author, DG has performed a total of 33,509 real-time ultrasound-guided musculoskeletal and peripheral nerve block injections and procedures using above-described sub-sterile protocol. Over this time, there have been 0 post-procedural musculoskeletal infections associated with our procedures. Thus, there was no perceived increased risk of musculoskeletal infection over sterile technique for direct ultrasound-guided musculoskeletal injections.

Patient follow up

Patient outcomes were determined by retrospective electronic medical record query for encounters related to musculoskeletal infection as well as direct patient follow up visits with our senior author DG or our mid-level nurse practitioner in 2 to 4 weeks. Patients were educated on the risks and possible adverse events of their procedures. Patients were also advised to seek immediate medical attention if they experienced new or worsening pain, redness, fever, swelling, or loss of function at the anatomical site of interest or surrounding structures. All patients, regardless of weight, age, or immunosuppressant status, were monitored using the same protocol.

Limitations and potential biases

Following treatment, all patients were scheduled for a follow-up appointment 2 to 4 weeks later with our nurse practitioner, RJ. At this visit, patients were examined for signs of infection and questioned regarding pain and perceived treatment outcomes. Some infections may not have been recalled or disclosed by patients, limiting detection. Additionally, minor or subclinical infections may have gone unnoticed. It is also possible that certain infections developed after the follow-up period and were therefore not captured. Furthermore, a subset of patients may have been lost to follow-up and failed to attend their scheduled post-treatment evaluation. In such cases, any infections they may have experienced would remain undocumented.

Statistical analysis

Infection rates between our cohort and the comparison cohort reported by Gorelik *et al*. (2022) [9] were assessed using Fisher's exact test due to low infection frequency. A two-sided p-value <0.05 was considered statistically significant. Among 33,509 procedures in our cohort, no post-injection infections were observed. In comparison, Gorelik *et al*. [9] reported one possible infection in 6,511 procedures. Fisher's exact test showed no statistically significant difference in infection rates (p=0.59). These findings support that our proposed sub-sterile protocol does not increase the risk of post-injection infection relative to the traditional sterile technique.

Table 1. Procedure count and musculoskeletal infection count.

Ultrasound-Guided Procedure	Procedure Count	Musculoskeletal Infections
Arthrocentesis, Aspiration, or Injection Intermediate Joint or Bursa	2,049	0
Arthrocentesis, Aspiration, or Injection Intermediate Joint or Bursa	5,708	0
Arthrocentesis, Aspiration or Injection of Small Joint or Bursa	990	0
Arthrodesis Metatarsophalangeal	1	0
Percutaneous Tenotomy of Lateral Medial Elbow	40	0
Injection of Anesthetic and/or Steroid at Transversus Abdominal Block	26	0
Injection of Anesthetic and/or Steroid at Transversus Abdominis Plane Block, Unilateral	4,061	0
Barbotage for Calcific Tendinosis	1	0
Drain or Inject Large Joint or Bursa	265	0
Drain or Inject Med Joint or Bursa	182	0
Drain or Inject Small Joint or Bursa	87	0

Foot/Toes Surgery	7	0
Injection of Anesthetic and/or Steroid at Plantar Digital Nerve	54	0
Injection of Anesthetic and/or Steroid at Axillary Nerve	16	0
Injection of Anesthetic and/or Steroid at Femoral Nerve	36	0
Injection of Anesthetic and/or Steroid at Sciatic Nerve	2,434	0
Injection of Anesthetic and/or Steroid at Single Tendon Origin	2,483	0
Injection at Trigger Point/1 or 2 Muscle Groups	132	0
Injection of Anesthetic and/or Steroid at Greater Occipital Nerve	330	0
Injection of Anesthetic and/or Steroid at Ilioinguinal/ Iliohypogastric Nerve	769	0
Injection of Anesthetic and/or Steroid at Intercostal Nerve and Additional Levels	803	0
Injection of Anesthetic and/or Steroid at Intercostal Nerve at Single Level	245	0
Injection of Anesthetic and/or Steroid at Other Peripheral Nerve or Branch	7,444	0
Injection of Anesthetic and/or Steroid at Pudendal Nerve	90	0
Injection of Anesthetic and/or Steroid at Suprascapular Nerve	173	0
Injection of Anesthetic and/or Steroid at Trigeminal Nerve Each Branch	19	0
Injection of Anesthetic and/or Steroid at Carpal Tunnel	1,271	0
Percutaneous Release of Palm Contract	37	0
Injection of Anesthetic and/or Steroid at Tendon Sheath Ligament	2,995	0
Injection of Anesthetic and/or Steroid at Tarsal Tunnel	761	0

Table 2. Fisher's exact test inputs: infection counts by group.

	Infections	No Infections	Total
Guo *et al.* (2025)	0	33,509	33,509
Gorelik *et al.* (2022)	1	5,708	6,511

Discussion

Ultrasound guidance allows the provider to perform procedures with the assurance provided by transparent visualization of the anatomy that significantly improves safety, reduces procedure time, and decreases patient discomfort. Our senior author DG's simplified, real-time ultrasound-guided musculoskeletal and peripheral nerve block injection approach has been used for over 30,000 procedures spanning 10 years. During this time, we performed numerous complicated injections including deep joint injections, nerve injections, as well as peripheral nerve compression and entrapment hydrodissections. Needles used in these procedures can be as long as 5-inches and as thick as 18 gauge. In addition, within our group of patients there were 17,434 procedures conducted on patients suffering with some level of obesity, ≥30 BMI, as well many suffering with diabetes mellitus. None of our patients have been excluded due to obesity or diabetes mellitus. However, we have not had a single post-procedure infection in the past 10 years, even among higher-risk patients. In addition, the Aurora Health System and BayCare Clinic have performed standard case reviews monthly and report monthly to each physician to ensure safety for patients.

Each procedure performed with our approach takes, at most, 10 minutes from preparation to finalization of the procedure by the provider. However, the traditional sterile approach requires approximately 30 minutes or more from preparation to finalization of procedure. These findings are to the benefit of reducing patient anxiety and intolerance to procedures. The reduction of procedure time will decrease exposure time thus theoretically decreases the infection risk. This is a significant difference in time that also may have an impact on the number of procedures a provider can perform in a day.

The use of full sterile technique for musculoskeletal and joint injections has been evaluated by various clinical groups, with findings suggesting that it may not be necessary in all cases.

Previous studies have assessed the impact of sterile versus non-sterile gloves in clinical procedures. One meta-analysis involving 3,227 patients randomized to wound repair using either sterile or clean non-sterile gloves found no statistically significant difference in infection rates between the groups [10]. These studies were performed in the ER on lacerations that the majority of infections were linked to bacterial contact at the time of injury, gloves were rarely if ever the source of infection.

Although the use of gloves is always recommended when performing injections, individually packaged sterile gloves have not been shown to significantly reduce infection rates. Additionally, sterile gloves are considerably more expensive, costing approximately $50 for a box of 50 compared to $60 for 1,000 non-sterile nitrile gloves [11,12]. This difference in cost may be a limiting factor for some providers preventing them from performing musculoskeletal and joint injections thus limiting patient access to effective therapies for pain management.

Bacterial load on a glove is also irrelevant as in DG's procedure the injection site is sterilized with ChloraPrep prior to injection thus bringing bacterial load in the surrounding area, the most likely source of infection, to below the infection risk threshold.

Similarly, the necessity of sterile transducer covers has come into question. While uncovered transducers demonstrated slightly higher relative light unit (RLU) values—2.29 compared to 0.34 for sterile covers—this difference was statistically significant. However, both values remained below the threshold for contamination (RLU <25), indicating that sterile covers do not significantly impact contamination rates and the statistical difference in RLU value is clinically irrelevant [13]. In DG's procedure a Tegaderm probe cover is used only for the transducer face to protect the probe from damage while also preventing patient-to-patient contamination.

These findings suggest that strict adherence to full sterile technique, including the use of sterile gloves, body drapes, and transducer covers, may not be essential for reducing infection risk in musculoskeletal and joint injections. Instead, a clean, standardized approach may offer a more cost-effective and equally safe alternative. The absence of a single infection over 10 years of DG's musculoskeletal and intra-articular joint injection procedures is consistent with the findings of these studies.

The primary advantages of our approach are a) significantly reduced procedure time, b) reduced procedure cost, c) may shift hospital-based procedures into clinical procedures such as sciatic nerve block, sacroiliac ligament and joint injection, lumbar facet joint injection, hip joint injection, abdominal wall nerve block and chest wall pain injections. Shifting hospital-based procedures to the clinical setting will improve patient access and cost of practice d) procedures may be finished by one person without assistance thus improving convenience of practice.

Limitations to the approach we propose primarily arise from the importance of providers having experience with ultrasound use. Familiarity with relevant sonographic anatomy contributes to the total duration of procedures as well as successful delivery of the medication. Providers may initially need to practice the approach we provide with the implementation of traditional strict sterilization to become familiar and to gain experience in the technique required.

Conclusion

While the consensus surrounding real-time ultrasound-guided musculoskeletal and peripheral nerve block injections is to use standard sterile protocol, there is a paucity of data supporting its use. Our approach aims to simplify real-time ultrasound-guided musculoskeletal and peripheral nerve block injections by proposing non-draping, non-sterile covering of transducer, and non-sterile glove-wearing conditions. This approach improves upon the standard sterile protocol by greatly reducing procedure time, effectively decreasing patient anxiety, increasing patient comfort, and reducing procedure cost thus lowering the barrier of entry for providers.

The safety of our simplified, real-time ultrasound-guided musculoskeletal and peripheral nerve block injection approach is clearly demonstrated by the lack of a single post-procedure infection resulting from over 30,000 procedures performed over 10 years. Our approach can be implemented safely without an associated increase in post-procedural musculoskeletal infection risk while simultaneously reducing the cost and duration of procedure when applied to real-time ultrasound-guided musculoskeletal and peripheral nerve block injections. The primary implication of this study is that with the proposed new approach, real-time ultrasound-guided musculoskeletal and peripheral nerve block injections can be performed without strict sterile technique with no increased risk of infection.

Limitations in the assessment of infection risk arise from possible underreporting of minor skin infections that did not warrant a healthcare encounter or follow up. Additionally, it is possible that infections were treated at other healthcare facilities or were lost to follow up. It is not feasible to fully account for infections that did not result in a healthcare encounter.

In conclusion, real-time ultrasound-guided musculoskeletal and peripheral nerve block injections can be performed using the simplified protocol developed by our senior author DG while maintaining or improving upon the inherent post-procedural infection risk present when the standard sterile antiseptic protocol is implemented. The proposed sub-sterile antiseptic protocol lowers barriers including cost and greatly reduces total duration of procedure, improving access to real-time ultrasound-guided musculoskeletal and peripheral nerve block injections.

Further research may be necessary. Future work may expand upon this study by including multi-center infection rates across multiple providers and across specialties that provide direct ultrasound-guided musculoskeletal and peripheral nerve block injections using the sub-sterile protocol developed by our senior author DG.

The approach we provide significantly improves the efficiency as well as the efficacy of real-time ultrasound-guided musculoskeletal and peripheral nerve block injections.

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