

ORIGINAL RESEARCH CONTRIBUTION

A Comparison of Ultrasound-guided Three-in-one Femoral Nerve Block Versus Parenteral Opioids Alone for Analgesia in Emergency Department Patients With Hip Fractures: A Randomized Controlled Trial

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Abstract

Objectives: The primary objective was to compare the efficacy of ultrasound (US)-guided three-in-one femoral nerve blocks to standard treatment with parenteral opioids for pain control in elderly patients with hip fractures in the emergency department (ED).

Methods: A randomized controlled trial was conducted at a large urban academic ED over an 18-month period. A convenience sample of older adults (age ≥ 55 years) with confirmed hip fractures and moderate to severe pain (numeric rating score ≥ 5) were randomized to one of two treatment arms: US-guided three-in-one femoral nerve block plus morphine (FNB group) or standard care, consisting of placebo (sham injection) plus morphine (SC group). Intravenous (IV) morphine was prescribed and dosed at the discretion of the treating physician; physicians were advised to target a 50% reduction in pain or per-patient request. The primary outcome measure of pain relief, or pain intensity reduction, was derived using the 11-point numerical rating scale (NRS) and calculated as the summed pain-intensity difference (SPID) over 4 hours. Secondary outcome measures included the amount of rescue analgesia and occurrence of adverse events (respiratory depression, hypotension, nausea, or vomiting). Outcome measures were compared between groups using analysis of variance for continuous variables and Fisher's exact test for categorical data.

Results: Thirty-six patients (18 in each arm) completed the study. There was no difference between treatment groups with respect to age, sex, fracture type, vital signs (baseline and at 4 hours), ED length of stay (LOS), pre-enrollment analgesia, or baseline pain intensity. In comparing pain intensity at the end of the study period, NRS scores at 4 hours were significantly lower in the FNB group ($p < 0.001$). Over the 4-hour study period, patients in the FNB group experienced significantly greater overall pain relief than those in the SC group, with a median SPID of 11.0 (interquartile range [IQR] = 4.0 to 21.8) in the FNB group versus 4.0 (IQR = -2.0 to 5.8) in the SC group ($p = 0.001$). No patient in the SC group achieved a clinically significant reduction in pain. Moreover, patients in the SC group received significantly more IV morphine than those in the FNB group (5.0 mg, IQR = 2.0 to 8.4 mg vs. 0.0 mg, IQR = 0.0 to 1.5 mg; $p = 0.028$). There was no difference in adverse events between groups.

Conclusions: Ultrasound-guided femoral nerve block as an adjunct to SC resulted in 1) significantly reduced pain intensity over 4 hours, 2) decreased amount of rescue analgesia, and 3) no appreciable difference in adverse events when compared with SC alone. Furthermore, standard pain management with parenteral opioids alone provided ineffective pain control in our study cohort of patients with severe pain from their hip fractures. Regional anesthesia has a role in the ED, and US-guided femoral

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Received September 25, 2012; revision received November 30 and December 12, 2012; accepted December 12, 2012.

Presented at the American College of Emergency Physicians Scientific Assembly, Las Vegas, NV, September 2010.

The Emergency Medicine Foundation and the Emergency Medicine Residents' Association provided funding for this study. The authors have no conflicts of interest to disclose.

Supervising Editor: James R. Miner, MD.

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nerve blocks for pain management in older adults with hip fractures should routinely be considered, particularly in cases of refractory or severe pain.

ACADEMIC EMERGENCY MEDICINE 2013; 20:584–591 © 2013 by the Society for Academic Emergency Medicine

Safe and effective pain control for emergency department (ED) patients with hip fractures can be challenging. At present, parenteral opioids are most commonly used for pain management. However, hip fractures typically afflict older individuals, often with other medical comorbidities, and the use of opioids in this population must be balanced with their potentially deleterious consequences. It has been demonstrated that older adults in the ED are at risk for oligoanalgesia, likely in part because of the concern of opioid-related side effects.^{1–3} Both the use of opioid medications and poor pain control have been associated with acute confusional states in the elderly.^{4,5} It is therefore necessary to investigate additional means of pain management in elder patients with hip fractures.

Regional anesthesia as an adjunct or alternative for pain management is increasingly being used in the ED for a variety of musculoskeletal presentations.⁶ Specifically, the three-in-one femoral nerve block, hereafter referred to as the femoral nerve block, holds promise as an analgesic adjunct to opioids in patients with a hip fracture.⁷ This single injection technique can anesthetize the three major nerves responsible for innervating the hip (lateral cutaneous, obturator, and femoral nerves), thereby maximizing analgesia to the hip. It is already well established as a perioperative adjunct to opioids for hip fracture repairs.^{8,9}

At present this technique is not routinely employed in the pain management of hip fracture patients in the ED, despite supporting evidence.³ We postulate that one of the reasons this technique has not gained widespread acceptance is that it historically has been a landmark or nerve stimulator guided procedure. The landmark-based technique confers the risks of a “blind” procedure, specifically inadvertent arterial puncture or injection, and nerve stimulators are not readily available in the ED and require additional training.

Ultrasound (US) guidance is an alternative approach that allows for visualized regional anesthesia. We have previously introduced the use of US-guided femoral nerve blocks as an efficacious and feasible tool for patients being treated for hip fractures in the ED.¹⁰ The advantages of US guidance are the widespread availability of US in the ED; emergency physician (EP) skill and comfort at performing other US-guided procedures, such as central venous access; and the ability of US to precisely visualize the femoral neurovascular anatomy. Anesthesiology research also suggests that US-guided femoral nerve blocks may be superior to other nerve block techniques in regard to onset of action and amount of anesthetic required.^{11,12}

To our knowledge, this technique has never been directly compared to standard care (SC) with parenteral opioids alone. The primary aim of this study was to determine if patients who receive an US-guided femoral nerve block in addition to opioids have superior pain relief when compared with patients who receive paren-

teral opioids alone. A superiority design was conducted given that the femoral nerve block is a more invasive procedure and its side effect profile is not well established in the acute setting. A secondary aim of this study was to determine if femoral nerve block reduced the use of parenteral opioids during the ED course. Last, we aimed to explore patient safety by evaluating the incidence of adverse events in patients receiving adjunctive femoral nerve block versus those receiving opioids alone.

METHODS

Study Design

A blinded, randomized controlled clinical trial with two study groups was performed. The study was registered at ClinicalTrials.gov (Identifier NCT01701414). The Emergency Medicine Foundation and the Emergency Medicine Residents’ Association provided funding for this study. The hospital’s institutional review board approved the study protocol and all participants provided written informed consent.

Study Setting and Population

This study was conducted at Rhode Island Hospital, a large, urban, academic ED with an annual census of over 100,000 adult visits per year. The hospital is a Level I trauma center and the ED houses an emergency medicine US fellowship. Patients were enrolled over an 18-month period from January 2009 through June 2010. Patients were eligible if they: were aged 55 years and older, had radiographically proven femoral neck or intertrochanteric fractures, normal lower extremity neurovascular examinations, were able to consent and actively participate in the study, and had moderate to severe pain (numerical pain rating score ≥ 5) at time of enrollment. Patients were excluded if they had a known international normalized ratio > 3.0 , prior femoral artery vascular surgery on the same side as the fracture, other significant trauma, hypoxia (pulse oximetry $< 92\%$), hypotension (systolic blood pressure < 100 mm Hg), or known hypersensitivity to local anesthetics or morphine.

Study Protocol

During times when a physician coinvestigator and trained research assistant (RA) were both available, RAs identified eligible patients by surveillance of the ED triage log, screening of electronic medical records, and discussion with providers. Each patient had an evaluation by the treating physician before recruitment for the study. Patients meeting inclusion and exclusion criteria were approached for consent by an RA. After consent, patients were randomized using sequentially numbered cards in sealed envelopes to one of two groups: femoral nerve block plus morphine (FNB) or standard care, morphine alone (SC). Randomization occurred using

an Internet-based program with a 1:1 allocation ratio and was performed by the department's research coordinator who was not involved in enrollment or data collection.

All procedures were performed by one of the three physician co-investigators. All investigators had prior experience performing the technique in clinical practice and underwent a 30-minute training session to standardize the approach.

Each participant randomized to the first group, FNB, received an US-guided femoral nerve block. The US-guided femoral nerve block was performed using a Sonosite Micromaxx (Sonosite, Inc., Bothell, WA) with a 7.5-MHz linear array transducer. The procedure was performed while the participant was in a supine Trendelenberg position. The skin was prepped with povidone iodine solution. The US probe was placed 1 cm distal to the inguinal ligament on the side of the affected hip to identify the femoral vessels and nerve in cross-section. The nerve was isolated as a hyperechoic structure approximately 1 cm lateral to the pulsatile artery and centered on the US screen for optimal viewing. A local skin wheal of 0.5% bupivacaine was made with a 27-gauge needle 2 cm lateral to the US probe. An 18-gauge needle was then used to puncture the skin 2 cm lateral to the US probe at the site of the skin wheal. At this puncture site, a 22-gauge Whitacre non-cutting spinal needle was introduced at a 45-degree angle in plane to the US probe, and 25 mL of bupivacaine was injected along the nerve sheath through this needle (Figure 1). The needle was directly visualized by US throughout the procedure to ensure that vascular puncture was avoided and that spread of local anesthetic was administered in the correct fascial plane. Immediately after the injection, manual pressure was held for 5 minutes 1 cm below the injection site. This was the same technique previously employed in our pilot feasibility and efficacy study.¹⁰

Each patient in the SC group received a sham injection of normal saline. The sham injection was intended to blind the participant and treating physician. The sham procedure consisted of placing a 7.5-MHz linear transducer on the side of the affected hip 1 cm below the inguinal ligament. One centimeter lateral to the US

probe, a 27-gauge needle and syringe was used to slowly inject 3 mL of 0.9% normal saline subcutaneously over a period of 5 minutes to approximate the time it would take to perform the femoral nerve block. It was felt unethical to give a full-volume placebo injection in proximity to neurovascular structures; therefore, the volume used was much less than the actual nerve block.

Following administration of the FNB or sham injection, each patient continued to receive SC: the EP caring for the patient chose analgesia dosing and frequency as per his or her practice, as well as appropriate consultations and admissions procedures. Physicians were instructed to use intravenous (IV) morphine and to target analgesia toward a self-reported decrease in patient discomfort of at least 50%. They were encouraged to wait at least 15 minutes after the study procedure before prescribing additional analgesia.

Outcome Measures

To assess our primary aim, pain relief, we used patient-reported pain scores. The primary efficacy variable was summed pain-intensity difference (SPID) over the 4-hour study period. SPID is a widely used variable to determine treatment response to analgesics over a relevant period of time and calculated using patient-reported pain scores.¹³ Trained RAs asked the participants to report their pain scores using an 11-point numerical rating scale (NRS) that ranged from 0 ("no pain") to 10 ("worst pain imaginable"). Baseline NRS scores were measured after randomization, but before administration of the FNB or sham injection. Repeat measurements were taken at 15 minutes and at 1, 2, and 4 hours after the study procedure. These measurements were chosen based on our prior experience that the largest decrease in patient-reported NRS occurs by 15 minutes postinjection (onset of action of bupivacaine is 5 to 10 minutes) and reaches its nadir by the first hour (bupivacaine effect peaks between 30 to 45 minutes). Two- and 4-hour time points were chosen because they span the expected half-life of bupivacaine, 2 to 3.5 hours, and hip fracture patients in our institution typically remain in the ED for at least that length of time after x-rays have been performed awaiting treatment, disposition, etc.

The primary variable, SPID, was calculated using the pain-intensity difference (PID) at each time point. The PID was calculated as the change from baseline NRS for each measurement in time. SPID was the summation of the PID at each of the study time points and weighted using the amount of time since the prior assessment; it approximates the area under the curve for PID over time. The benefit of using SPID is that it takes into account individual differences in baseline pain intensity, as well as time. SPID is also reported as a percentage of maximum possible SPID (%SPID). Maximum possible SPID is the value that would be achieved if the patient were pain free (NRS = 0) for the entire study period. We were specifically interested in the number of patients who achieved a %SPID of 33%. A PID of 33% has been previously established to represent clinically important measurement in pain outcomes.¹⁴

To assess our secondary aim, that the femoral nerve block would reduce opioid use, we reviewed the ED elec-

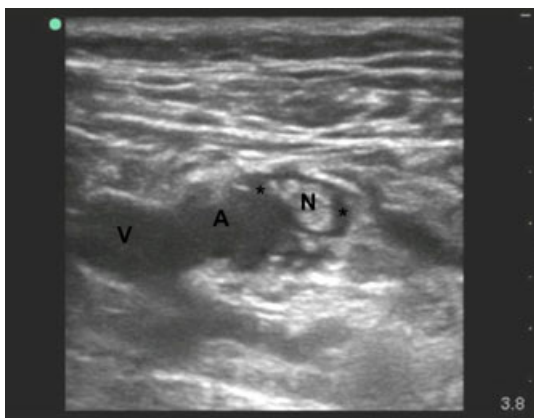


Figure 1. US image of femoral nerve (N), artery (A), and vein (V) in cross-section immediately following injection of anesthetic. Anesthetic (*) is surrounding the nerve. US = ultrasound.

tronic medical record and recorded time and dose of analgesics administered. All medication orders are placed in the ED electronic record. This secondary efficacy variable was the total amount of opioid received after the study procedure, while the patient was in the ED. In instances where a provider gave another opioid besides morphine, morphine equivalents were calculated.

Finally, regarding safety, we aimed to measure the occurrence of adverse events in our study group, specifically the presence of nausea or vomiting, hypotension, and respiratory depression (hypoxia and hypopnea). Nausea or vomiting was defined as patient-reported nausea, documented emesis, or administration of an antiemetic drug during study enrollment. Hypotension was defined as a systolic blood pressure reading below 100 mm Hg at any time after the study intervention. Hypoxia was defined as an oxygen saturation < 92% measured by pulse oximetry or the need for supplemental oxygen any time after the study intervention. Hypopnea was defined as a respiratory rate of <10 breaths/min. Other adverse events were documented per patient, nurse, or treating physician report and the ED record was reviewed independently by two of the physician coinvestigators (FLB, JPH) to assess for other adverse events including, but not limited to, naloxone administration, cardiac dysrhythmias, and agitation or confusion.

Data Analysis

The sample size was calculated based on effect sizes previously established in our pilot study.¹⁰ It was determined that a sample size of 17 subjects in each arm would provide 80% power to detect at least a 33% PID with a significance level of $\alpha < 0.05$ (two-tailed). Sample size was inflated by 10% to account for attrition, missing data, and protocol violations, for a total of 19 subjects in each arm.

Patient characteristics and outcome measures are reported as means, standard deviations (SDs), medians, ranges, and percentages as appropriate. Descriptive and inferential statistical analyses (analysis of variance [ANOVA] for continuous variables, Fisher's exact test for categorical data) were performed using STATA 10.0 statistical software (StataCorp LP, College Station, TX). Two-way ANOVA with repeated measures in one factor (time) was performed to compare the effect of treatment (FNB or SC) over time on pain-intensity measures (NRS and PID scores). Association between rescue analgesia and SPID for each group was tested using Pearson's product moment. Parametric statistics were used as the data were normally distributed and the assumptions of ANOVA were satisfied. A p-value of <0.05 was considered significant.

RESULTS

Sixty-four patients were screened for the study; 38 patients were enrolled. Of the patients not enrolled, reasons were lack of at least moderate pain at time of screening, inability to provide informed consent, not interested in participation, and sensitivity to morphine. Two patients who were enrolled (one in each arm) dropped out after randomization, but before the study

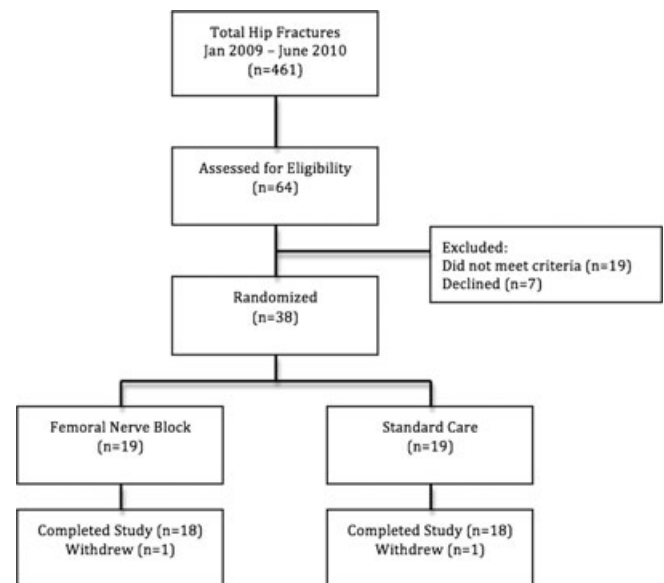


Figure 2. Study enrollment flow chart.

Table 1
Patient Characteristics and Vital Signs by Group Assignment

Characteristics	FNB Group	SC Group	p-value
Age (yr),	82 (64–98)	82 (65–97)	0.776
Female sex, <i>n</i> (%)	11 (61)	13 (81)	0.725
Femoral neck fracture, <i>n</i> (%)	6 (33)	8 (44)	0.733
ED LOS (minutes)	480 (324–670)	510 (341–704)	0.799
Vital signs			
Initial sBP (mm Hg)	167 (105–196)	162 (102–204)	0.410
Initial HR (beats/min)	74 (63–105)	79 (71–105)	0.728
Initial O ₂ sat (%)	96 (93–99)	97 (94–100)	0.237
4-hour sBP (mmHg)	147 (103–196)	150 (94–182)	0.177
4-hour HR (beats/min)	75 (72–91)	90 (56–109)	0.697
4-hour O ₂ sat (%)	98 (95–99)	96 (93–99)	0.273
Unless otherwise specified, data are presented as median (range). ED LOS = ED length of stay; FNB = femoral nerve block; HR = heart rate; sBP = systolic blood pressure; O ₂ sat = oxygen saturation; SC = standard care.			

procedure. Eighteen patients in each arm completed the study (Figure 2).

Summary characteristics of patients are presented in Table 1. There was no significant difference between treatment groups with respect to age, sex, fracture type, vital signs (baseline and at 4 hours), or length of stay (LOS). There was no significant difference in pre-enrollment analgesia or baseline pain intensity (Table 2). Mean pain-intensity scores (measures with an NRS) and PID over 4 hours are displayed in Figures 3 and 4. A PID ≥ 2 is considered clinically significant.¹⁴ There was a significant decrease in pain intensity (decrease NRS and increase PID) in the patients in the FNB group over time ($p < 0.01$), whereas those in the SC group did not have any change in pain intensity over time ($p = 0.882$; ANOVA, group \times time interaction). In comparing overall pain relief between treatment groups, our primary

Table 2
Patient Outcomes by Group Assignment

Outcome	FNB Group	SC Group	p-value
Pain scores			
NRS			
Baseline	8.3 (5 to 10)	8.0 (5 to 10)	0.300
4 hours	4.0 (0 to 10)	8.0 (6 to 10)	<0.001*
SPID			
%SPID (%)	11.0 (-4.0 to 44.0)	4.0 (-7.0 to 11)	0.001*
33%SPID, n (%)	36.9 (-25 to 100)	13.4 (-25 to 27.5)	0.001*
	12 (67)	0 (0)	<0.001*
Parenteral analgesia			
Preprocedure morphine (mg)	3.0 (0.0 to 20.0)	5.5 (0.0 to 16.0)	0.489
Rescue morphine (mg)	0.0 (0.0 to 6.0)	5.0 (0.0 to 21.0)	0.028*
Adverse events			
Hypotension, n (%)	0 (0)	3 (17)	0.229
Respiratory depression, n (%)	4 (22)	9 (50)	0.164
Nausea/vomiting, n (%)	5 (28)	5 (28)	1.000

Unless otherwise specified, data are presented as median (range).
 FNB = femoral nerve block; NRS = numeric rating scale; SC = standard care; SPID = summed pain-intensity difference.
 Hypotension defined as systolic BP < 100 mm Hg at any time during study period; respiratory depression defined as hypoxia (room air O₂ sat < 92% or need for supplemental O₂ any time during study period) or hypopnea (respiratory rate < 10 breaths/min)
 *Statistically significant (p < 0.05).

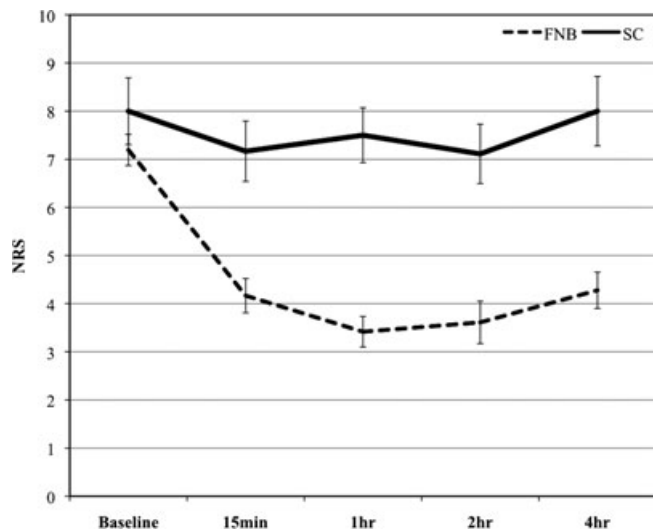


Figure 3. Pain intensity scores (NRS) over time by group: FNB and SC. Data are represented as mean ± standard error. FNB = femoral nerve block; NRS = numerical rating scale; SC = standard care.

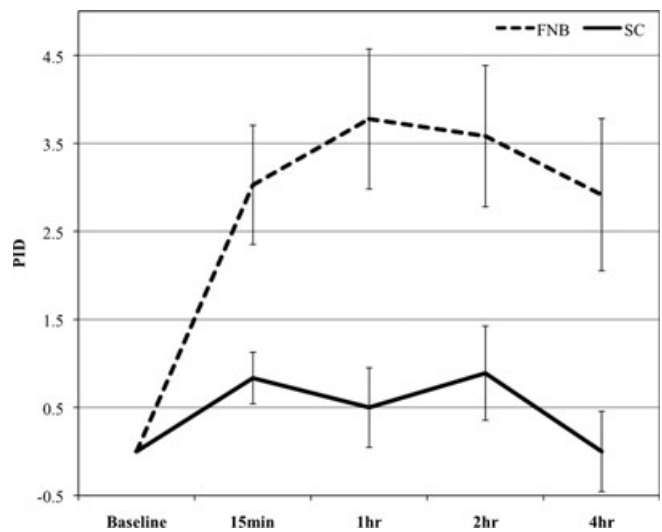


Figure 4. Change in pain intensity (PID) over time FNB and SC. Data are represented as mean ± standard error. FNB = femoral nerve block; PID = pain-intensity difference; SC = standard care.

outcome measure, the SPID over 4 hours was significantly greater in the FNB group (Table 2). Additionally, a significantly higher proportion of individuals in the FNB group achieved at least 33% reduction in pain intensity over time (33%SPID); six patients had a 50% decrease in pain intensity over time. No individual in the SC group achieved a 33% reduction in pain. The highest percentage of pain relief reported by an individual in the SC group was 23%; one-third of the SC group (n = 6) had negative %SPID, indicating increasing pain intensity over the study period. One individual in the FNB group had a negative %SPID.

Regarding our second outcome measure, parenteral opioid use, patients in the FNB group received signifi-

cantly less parenteral opioid than those in the SC group (Table 2). Five patients in the FNB group received rescue analgesia, compared with 14 patients in the SC group. All of the patients who received rescue analgesia received morphine. In addition to morphine, three patients in the SC group received hydromorphone and one received fentanyl; one patient in the FNB group received hydromorphone, in addition to morphine. The range of rescue opioid doses ranged widely between groups, 2 to 6 mg (morphine equivalents) in the FNB group and 2 to 21 mg in the SC group. There was no significant association between dose of rescue analgesia and %SPID in the FNB group (r = -0.07, r² = 0.005) and only a weak association in the SC group (r = 0.20, r² = 0.04).

There were no differences in the rates of hypotension, hypoxia, or nausea/vomiting. No patient in either group experienced a depressed respiratory rate. One patient in the SC group had an episode of rapid atrial fibrillation requiring diltiazem, but the patient had a history of chronic atrial fibrillation. No other adverse events were noted during the study period, and no other adverse events were reported to study investigators.

DISCUSSION

To our knowledge, this is the first randomized controlled study in the ED to demonstrate that US-guided FNB as an adjunct to parenteral opioids provides superior pain relief than parenteral opioids alone. Patients in the treatment arm had effective and sustained pain relief over the 4-hour study period, unlike patients in the SC arm. Over two-thirds of the patients in the FNB group sustained clinically important changes in pain; six patients experienced > 50% sustained pain relief over the study period. No patient in the SC group sustained a clinically significant change in pain; in fact, six patients in the SC group (and one in the FNB group) sustained increased pain intensity over the study period (negative %SPID).

Moreover, patients in the SC group received higher doses of morphine, but with inferior pain relief compared to the FNB patients. This supports what is known from anesthesiology literature in the perioperative environment and corroborates prior work by Fletcher et al.⁷ who examined a landmark-based approach against morphine in ED patients in an unblinded study. Our study results argue that we underuse this method of pain control in the ED and further highlight that standard means of pain control in hip fracture patients are inadequate.

Regional anesthesia has been used for hip fracture repairs since the 1970s, and Finlayson and Underhill¹⁵ first reported its application in the ED in the late 1980s. Despite decades of precedence, it is still not standard of care to administer regional anesthesia to hip fracture patients when in the ED. A large, multicenter Australian cohort study examining pain control in hip fractures reported that regional anesthesia was used in only 7% of cases.³ Possible barriers to implementation of this method of pain control may include lack of familiarity with the procedure, perception that morphine alone is effective, and safety concerns of the procedure.

Emergency physicians are adept at using US guidance for several procedures that were previously landmark-based. While not the goal of this study, we advocate that US-guided regional anesthesia is a procedural skill that can be acquired by the average EP with training in US. US-guided regional anesthesia is also growing in popularity, and several recent studies have documented its use for a variety of traumatic disorders in the emergent setting.¹⁶⁻¹⁸ Another recent study demonstrated feasibility of US-guided fascia iliaca compartment block, an alternative approach to regional anesthesia in hip fractures.¹⁹ This regional block relies on higher volumes of local anesthetic (typically 40 to 50 mL) injected below the fascia iliaca (which covers the femoral nerve). The "compartment" of anesthetic then

spreads caudally, anesthetizing the lateral cutaneous, obturator, and femoral nerves and delivering analgesia to the hip in a manner similar to the three-in-one block. The three-in-one block probably requires that anesthetic be delivered in a more precise location, but uses about half the anesthetic volume. These two techniques have shown similar efficacy in total knee arthroplasty patients.²⁰ We chose to evaluate the three-in-one block, as this was the method implemented in our prior feasibility study.¹⁰

Overall, it is important that EPs are willing to explore alternative methods of pain control given that opioids alone are often not sufficient to alleviate pain. Bijur et al.²¹ demonstrated that 0.1 mg/kg morphine, a standard analgesic dose of morphine, is ineffective at controlling severe pain. Patients in the SC arm of the study received a mean of 0.14 mg/kg morphine during their ED course (pre- and postenrollment) with insufficient analgesia. Doses also varied widely in this group, with a range of 2 to 34 mg over the ED course, but there was only a weak relationship between analgesic dose and pain relief. Based on this we can hypothesize that patients in the SC arm experienced oligoanalgesia both because providers prescribed insufficient analgesia, and the analgesia that was prescribed was inadequate. Morphine alone is probably ineffective for pain control in all patients, and we must find other adjunctive means to control pain, particularly in vulnerable populations such as elderly hip fracture patients. Poor pain control is highly predictive of delirium in the elderly, and delirium is directly related to mortality.^{5,22}

Our study did not detect any adverse effects specifically related to the FNB. There were no differences in the incidence of hypotension and respiratory depression between groups; however, the study was not powered to detect a difference in adverse events. Further work is needed to characterize whether or not the use of FNBs affects the incidence of adverse events and morbidity in this population.

While we believe that regional anesthesia is a viable adjunct to morphine for pain control in hip fractures, pain management in this population still remains a challenge. One-third of the patients in the FNB group did not achieve clinically significant changes in pain, and only one patient in the entire study (FNB group) was completely pain-free at the end of the study period. We postulate that variations in rescue analgesia, operator technique, patient perception of pain, and innervations of the hip itself probably account for the variable effect of the FNB.

LIMITATIONS

This study was limited by lack of standardized approach to rescue analgesia, meaning that this was left to the discretion of the treating physician. It is possible that if patients randomized to receive SC alone had receive higher or more frequent dosing of opioids, they might have achieved pain scores similar to those patients in the treatment arm of the study. Our study demonstrates that the addition of the FNB provides more efficacious pain control than morphine dosing as left up to the treating physician. While this study is reflective of only

one academic institution, it mirrors other recent studies that demonstrate that analgesic dosing practices do not always follow recommended guidelines.²³ Therefore, our study findings are immediately applicable to current practice.

Additionally, we excluded patients who had only mild to moderate pain (NRS < 5); therefore, we isolated patients with refractory pain. The role of femoral nerve block in patients with lesser degrees of pain is thus uncertain. We presume that femoral nerve block is still a suitable adjunct or perhaps alternative to morphine in these patients, but morphine alone may have been effective in these patients. By excluding patients with mild pain, it is possible that we may have biased results in favor of the femoral nerve block. However, we specifically targeted patients with uncontrolled, severe pain, as it was felt that these patients were most in need of adjunctive pain management.

Last, we did not examine outcomes beyond the ED. The goal of our study was to establish efficacy compared to SC. The natural evolution of this line of inquiry is to examine whether or not the use of FNBs and improved pain control can affect adverse outcomes, morbidity, and mortality. This was beyond the scope of this initial study.

CONCLUSIONS

Our data support the routine consideration of the femoral nerve block for pain management in ED patients with hip fractures as an adjunct to morphine, particularly in refractory moderate to severe pain. Use of the femoral nerve block increases the likelihood of clinically significant improvements in pain, without an appreciable difference in adverse events. Future studies should examine additional outcomes, specifically if use of regional anesthesia affects the development of delirium, length of stay in the hospital, and time to operative intervention, as these factors are directly related to mortality in hip fracture patients. Subsequent studies could also examine other techniques, such as continuous infusion or fascia iliaca blocks, as well as other indications for regional anesthesia.

The authors are grateful to Mr. Fenwick Gardiner for his significant effort as a research assistant on this study.

References

1. Platts-Mills TF, Esserman DA, Brown DL, Bortsov AV, Sloane PD, McLean SA. Older US emergency department patients are less likely to receive pain medication than younger patients: results from a national survey. *Ann Emerg Med.* 2012; 60:199–206.
2. Jones JS, Johnson K, McNinch M. Age as a risk factor for inadequate emergency department analgesia. *Am J Emerg Med.* 1996; 14:157–60.
3. Holdgate A, Shepherd SA, Huckson S. Patterns of analgesia for fractured neck of femur in Australian emergency department patients. *Emerg Med Australas.* 2010; 22:3–8.
4. Vaurio LE, Sands LP, Wang Y, Mullen EA, Leung JM. Postoperative delirium: the importance of pain and pain management. *Anesth Analg.* 2006; 102:1267–73.
5. Morrison RS, Magaziner J, Gilbert M, et al. Relationship between pain and opioid analgesics on the development of delirium following hip fracture. *J Gerontol A Biol Sci Med Sci.* 2003; 58:76–81.
6. De Buck F, Devroe S, Missant C, Van de Velde M. Regional anesthesia outside the operating room: indications and techniques. *Curr Opin Anaesthesiol.* 2012; 25:501–7.
7. Fletcher AK, Rigby AS, Heyes FL. Three-in-one femoral nerve block as analgesia for fractured neck of femur in the emergency department: a randomized, controlled trial. *Ann Emerg Med.* 2003; 41:227–33.
8. Parker MJ, Griffiths R, Appadu BN. Nerve blocks (subcostal, lateral cutaneous, femoral, triple, psoas) for hip fractures. *Cochrane Database Syst Rev.* 2002:CD001159.
9. Kullenberg B, Ysberg B, Heilman M, Resch S. [Femoral nerve block as pain relief in hip fracture. A good alternative in perioperative treatment proved by a prospective study] [Swedish]. *Lakartidningen.* 2004; 101:2104–7.
10. Beaudoin FL, Nagdev A, Merchant RC, Becker BM. Ultrasound-guided femoral nerve blocks in elderly patients with hip fractures. *Am J Emerg Med.* 2010; 28:76–81.
11. Marhofer P, Schrogendorfer K, Wallner T, Koinig H, Mayer N, Kapral S. Ultrasonographic guidance reduces the amount of local anesthetic for 3-in-1 blocks. *Reg Anesth Pain Med.* 1998; 23:584–8.
12. Marhofer P, Schrogendorfer K, Koinig H, Kapral S, Weinstabl C, Mayer N. Ultrasonographic guidance improves sensory block and onset time of three-in-one blocks. *Anesth Analg.* 1997; 85:854–7.
13. Farrar JT, Portenoy RK, Berlin JA, Kinman JL, Strom BL. Defining the clinically important difference in pain outcome measures. *Pain.* 2000; 88:287–94.
14. Farrar JT, Berlin JA, Strom BL. Clinically important changes in acute pain outcome measures: a validation study. *J Pain Symptom Manage.* 2003; 25:406–11.
15. Finlayson BJ, Underhill TJ. Femoral nerve block for analgesia in fractures of the femoral neck. *Arch Emerg Med.* 1988; 5:173–6.
16. Liebmann O, Price D, Mills C, et al. Feasibility of forearm ultrasonography-guided nerve blocks of the radial, ulnar, and median nerves for hand procedures in the emergency department. *Ann Emerg Med.* 2006; 48:558–62.
17. Blaivas M, Adhikari S, Lander L. A prospective comparison of procedural sedation and ultrasound-guided interscalene nerve block for shoulder reduction in the emergency department. *Acad Emerg Med.* 2011; 18:922–7.
18. Herring AA, Stone MB, Fischer J, et al. Ultrasound-guided distal popliteal sciatic nerve block for ED anesthesia. *Am J Emerg Med.* 2011; 29:697. e3–5.
19. Haines L, Dickman E, Ayvazyan S, et al. Ultrasound-guided fascia iliaca compartment block for hip fractures in the emergency department. *J Emerg Med.* 2012; 43:692–7.
20. Brisbane Orthopaedic & Sports Medicine Centre Writing Committee, McMeniman TJ, McMeniman

- PJ, et al. Femoral nerve block vs fascia iliaca block for total knee arthroplasty postoperative pain control: a prospective, randomized controlled trial. *J Arthroplasty*. 2010;25:1246–9.
21. Bijur PE, Kenny MK, Gallagher EJ. Intravenous morphine at 0.1 mg/kg is not effective for controlling severe acute pain in the majority of patients. *Ann Emerg Med*. 2005; 46:362–7.
22. Marcantonio ER, Flacker JM, Michaels M, Resnick NM. Delirium is independently associated with poor functional recovery after hip fracture. *J Am Geriatr Soc*. 2000; 48:618–24.
23. Bijur PE, Esses D, Chang AK, Gallagher EJ. Dosing and titration of intravenous opioid analgesics administered to ED patients in acute severe pain. *Am J Emerg Med*. 2012; 30:1241–4.

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