



Brief Report

Ultrasound-guided femoral nerve blocks in elderly patients with hip fractures ☆, ☆ ☆

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Received 16 June 2008; revised 30 August 2008; accepted 3 September 2008

Abstract

Objectives: The primary objective of this study was to determine the feasibility of ultrasound-guided femoral nerve blocks in elderly patients with hip fractures in the emergency department (ED). The secondary objective was to examine the effectiveness of this technique as an adjunct for pain control in the ED.

Methods: This prospective observational study enrolled a convenience sample of 13 patients with hip fractures. Ultrasound-guided femoral nerve block was performed on all participants. To determine feasibility, time to perform the procedure, number of attempts, and complications were measured. To determine effectiveness of pain control, numerical rating scores were assessed at baseline and at 15 minutes, 30 minutes, and hourly after the procedure for 4 hours. Summary statistics were calculated for feasibility measures. Wilcoxon matched-pairs signed-rank tests and Friedman analysis of variance test were used to compare differences in pain scores.

Results: The median age of the participants was 82 years (range, 67–94 years); 9 were female. The median time to perform the procedure was 8 minutes (range, 7–11 minutes). All procedures required only one attempt; there were no complications. After the procedure, there were 44% and 67% relative decreases in pain scores at 15 minutes ($P \leq .002$) and at 30 minutes ($P \leq .001$), respectively. Pain scores were unchanged from 30 minutes to 4 hours after the procedure ($P \leq .77$).

Conclusions: Ultrasound-guided femoral nerve blocks are feasible to perform in the ED. Significant and sustained decreases in pain scores were achieved with this technique.

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☆ Sources of Support: All equipment, supplies and cost were supported by the: University Emergency Medicine Foundation/Department of Emergency Medicine, Rhode Island Hospital, Providence, RI.

☆☆ Prior Presentations: Oral presentation. WINFOCUS: 4th World Congress on Ultrasound in Emergency and Critical Care Medicine. March 2008. Porto Alegre, Brazil.

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1. Introduction

The 3-in-1 femoral nerve block is well established as a perioperative analgesic adjunct for hip fracture repairs. The 3-in-1 femoral nerve block, hereafter referred to as the femoral nerve block, involves anesthetizing the lateral cutaneous, obturator, and femoral nerves using a single injection. Anesthesiology researchers have demonstrated

that this type of regional anesthesia delivered in the operative setting is effective in controlling pain and diminishing postoperative narcotic use [1-3]. Because patients who sustain hip fractures are typically first evaluated in the emergency department (ED), this procedure has the potential for pain control in the acute medical setting. Prior research has demonstrated feasibility and effective pain control of the femoral nerve block in the ED setting; however, investigators relied on a landmark-based technique rather than using aids to locate the femoral nerve [4-6]. The landmark technique is not an ideal option for this procedure because of the increased risk of inadvertent injection of anesthetic into the femoral vessels, which poses the risk of systemic life-threatening adverse events. Bupivacaine, the most commonly used anesthetic, carries the risk of ventricular arrhythmias, heart block, hypotension, and respiratory arrest if injected into the systemic circulation.

Bedside ultrasound (US) can be used to precisely visualize the femoral neurovascular anatomy when performing a femoral nerve block and has distinct advantages when performing this procedure in the ED setting. Bedside US has rapidly become integrated in the education and practice of emergency medicine and is already used as a safer approach to other landmark-guided techniques, such as central venous access. In the operative setting, the femoral nerve block is most often conducted using a nerve stimulator. However, nerve stimulators are not readily available in the ED and require additional costs and specialized training. In addition, anesthesiology research suggests that US-guided femoral nerve blocks may be superior to nerve stimulator-guided nerve blocks in regard to onset of action and amount of anesthetic required [7,8]. In this article, we introduce the use of US-guided femoral nerve blocks as a tool for visualized regional anesthesia in patients being treated for hip fractures in the ED.

There are no published data reporting the use of US-guided femoral nerve blocks in the ED. The primary objective of this pilot study was to examine the feasibility of this technique in the ED, and the secondary objective was to examine its effectiveness as an adjunct to pain control for hip fractures evaluated in the ED. If shown to be feasible and effective in the ED, the importance of this technique for emergency medicine is 2-fold: (1) it would provide a safer alternative to the landmark-based technique, and (2) it would permit the practitioner to control pain in elder patients with hip fractures while avoiding the deleterious consequences of parenteral narcotics in this population.

2. Materials and methods

2.1. Study design and selection of participants

This prospective observational pilot study was conducted at a large urban academic ED with a US fellowship.

Over an 8-week period, a convenience sample of 13 patients who presented to the ED with isolated hip fractures was enrolled. Patients were eligible if they were 65 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, received no more than one dose of parenteral analgesia, and had pain from their hip fracture at time of enrollment. All procedures were performed by 2 of the co-investigators: an emergency medicine resident and an ultrasound fellowship-trained emergency medicine attending physician. The attending was experienced in administering US-guided femoral nerve blocks. The resident underwent a 30-minute training session conducted by this attending physician on how to perform the technique. The hospital's institutional review board approved the study protocol. All participants provided written informed consent.

2.2. Study intervention: US-guided femoral nerve block

All participants received a US-guided femoral nerve block using a Sonosite Titan (Sonosite, Inc, Bothell, Wash) with a 7.5-MHz linear array transducer. The procedure was performed while participants were in a supine Trendelenburg position (Fig. 1A). The skin was prepared 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 (Fig. 1B). The nerve was isolated as a hyperechoic structure approximately 1 cm lateral to the pulsatile artery and was 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 noncutting spinal needle was introduced at a 45° angle in-plane to the US probe and 25 mL of 0.5% bupivacaine was injected along the nerve sheath through this needle (Fig. 1C). Noncutting spinal needles have previously been used in other types of nerve blocks administered in the ED because they reduce the possibility of neurologic and vascular injury [9]. The needle was directly visualized throughout the procedure to ensure that vascular puncture was avoided and that spread of local anesthetic was administered in the correct fascial plane (Fig. 2). The injection was made with US probe oriented to the short access of the nerve and long axis of the needle for the nerve, artery, needle, and spread of anesthetic to be visualized simultaneously. Immediately after the injection, manual pressure was held for 5 minutes 1 cm below the injection site (Fig. 1D). The use of direct pressure on the site while patients are in Trendelenburg facilitates the spread of the anesthetic in a cephalad direction. This process anesthetizes the obturator, lateral cutaneous, and the femoral

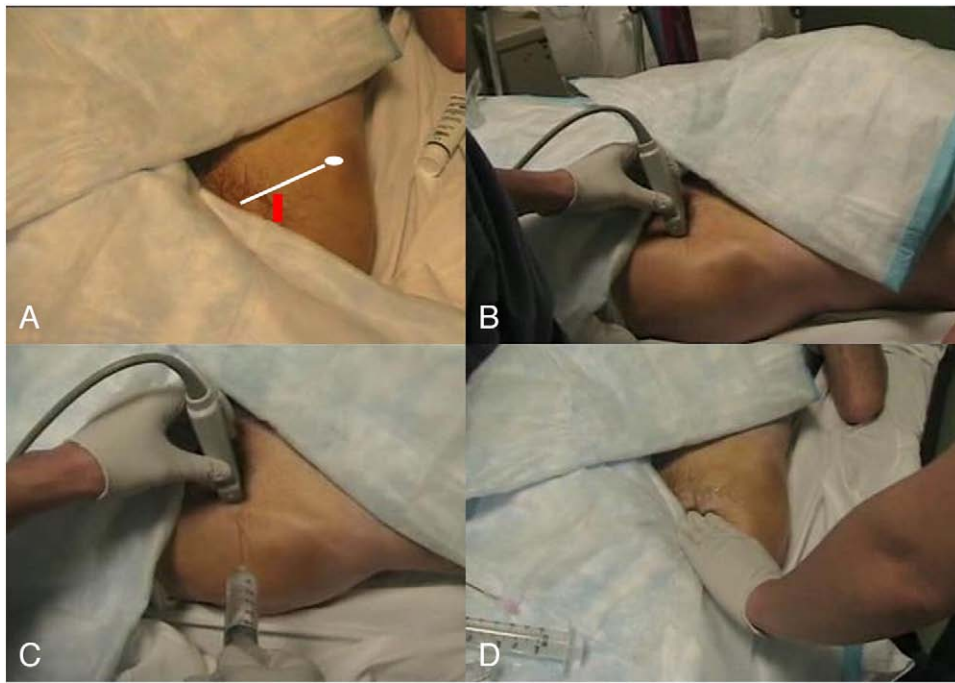


Fig. 1 Ultrasound-guided femoral nerve block. A, Supine patient demonstrating landmarks of the anterior superior iliac spine (white oval), inguinal ligament (white line). B, Orientation of US probe. C, Injection of anesthetic. D, Manual pressure distal to the injection.

nerves, which supply the main sensory innervation to the hip. This method was first published as a blind procedure by Winnie et al and has been since adapted to include the use of US [8,10].

After the US-guided nerve block, the emergency physicians caring for the patient administered parenteral analgesia as per their practice or patient request. Investigators gathered data about analgesic administration for these patients.

2.3. Data collection and processing, and outcome measures

To assess the feasibility of US-guided femoral nerve blocks, we recorded time to perform the procedure, number of attempts, and complications. The time to perform the procedure was marked from initial US to completion of the procedure (including manual pressure for 5 minutes). An attempt was defined as an injection requiring skin puncture.

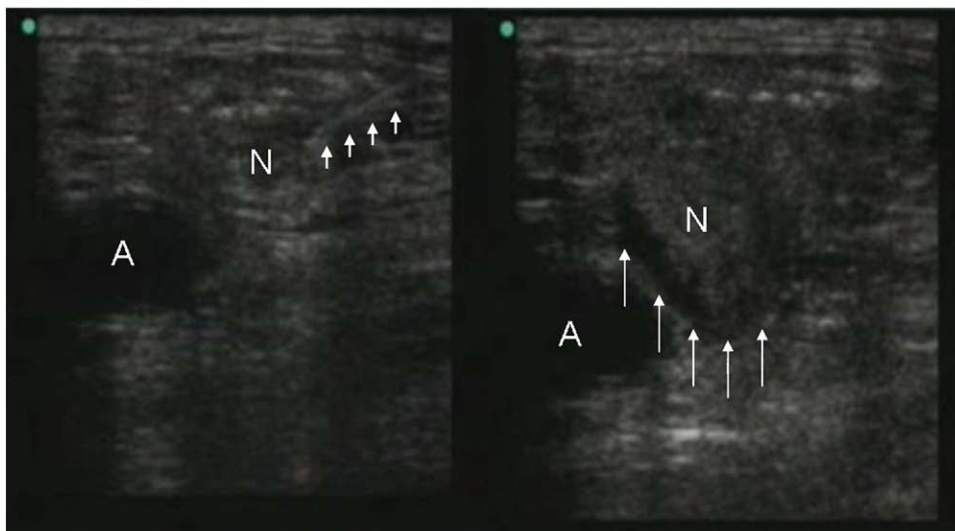


Fig. 2 Ultrasound images of the femoral nerve block. Left, Before anesthetic injection: artery (A), nerve (N), and needle (indicated by short white arrows). Right, After anesthetic injection: artery (A), nerve (N), with anesthetic surrounding the nerve (outlined by long white arrows).

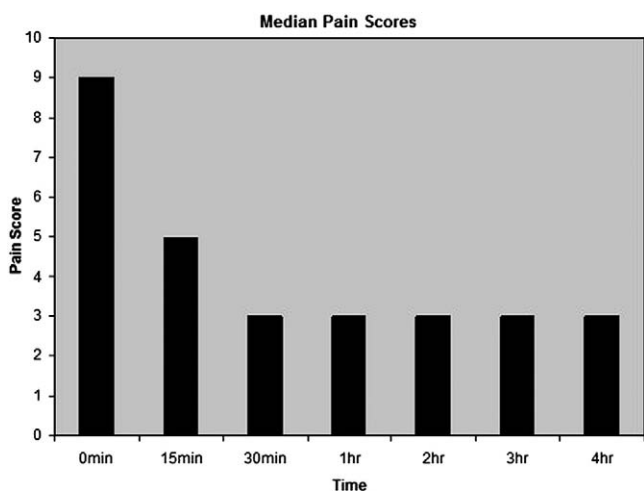


Fig. 3 Median pain scores over 4 hours.

Complications were defined as vascular puncture (aspiration of blood), nerve puncture (severe pain in distribution of femoral nerve upon injection), hematoma, or any other adverse event.

To assess pain control, we used patient reported pain scores and the amount of additional intravenous morphine the patient received (rescue analgesia) after the nerve block. Trained research assistants asked participants to report their pains scores using a numeric rating scale that ranged from 0 (“no pain”) to 10 (“worst pain imaginable”). This pain scale has been shown to be an acceptable tool for use with older adults [11]. Pain scores were measured immediately before the femoral nerve block was administered, and then 15 minutes, 30 minutes, and hourly for 4 hours after completion of the procedure. The 4-hour time limit was chosen because this was typically the maximum time participants spent in the ED before being transported to their inpatient bed. The amount of rescue analgesia was also recorded at each time point. Participant demographic characteristics and fracture type were also recorded.

The femoral nerve block was considered successful if (1) the femoral nerve was visualized on US; (2) the subject had sensory hypoesthesia of the thigh, as measured by pin prick; and (3) the subject had decreased pain scores after the procedure.

2.4. Statistical analysis

Summary statistics of the time to perform the procedure, number of attempts, and complications, and amount of morphine administered for each participant were calculated. The median pain scores for all participants were calculated for each recorded time point. Individual and all participant median pain scores over the recorded time points were graphed. Wilcoxon matched-pairs signed-rank tests and Friedman analysis of variance test were used to compare differences in pain scores across 2 or more time points, respectively. Relative changes in median scores from

baseline assessment were calculated. Differences were considered significant at the $\alpha = .05$ level.

3. Results

Seventeen patients were screened for enrollment; thirteen were enrolled. Of the 4 not enrolled, 2 had no pain at the time of screening and 2 were not able to consent because of impaired mental status. The median age was 83 years (range, 67-94 years) and 9 were female. Seven subjects had femoral neck fractures; the remainder had intertrochanteric fractures.

The median time to perform the procedure was 8 minutes (range, 7-11 minutes). All procedures required only one attempt. There were no complications. Fig. 3 shows the median pain scores over the 4-hour study period. Compared to the baseline pain scores, there was a 44% relative decrease in the median pain scores at 15 minutes ($P \leq .002$) and a 67% relative decrease at 30 minutes ($P \leq .001$). Pain scores were unchanged from 30 minutes to 4 hours after the procedure ($P \leq .77$). Eleven subjects received a median dose of 4 mg (range, 2-10 mg) of morphine at a median time of 95 minutes (range, 40-164 minutes) before the US-guided nerve block. Only 3 subjects of 13 required a dose of rescue analgesia. One subject received 4 mg of morphine at 1 hour, a second subject received 2.5 mg at 2 hours, and a third subject 5 mg at 4 hours after the procedure (Fig. 4).

In terms of success in performing the procedure, the femoral nerve was visualized in all subjects. In regard to success in achieving pain relief, all subjects also experienced sensory anesthesia of the thigh and had decreased pain scores after the procedure. Therefore, the US-guided femoral nerve block was 100% successful in our subject group by the a priori criteria established for this study.

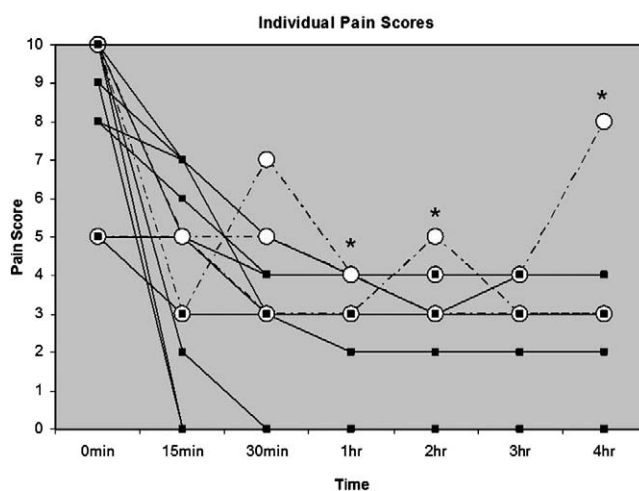


Fig. 4 Individual pain scores over 4 hours. The closed squares represent participants who did not receive rescue analgesia, whereas the open circles represent those who did. Administration of rescue analgesia is indicated by an asterisk over the specific individual and time at which it was given.

4. Discussion

This pilot study demonstrates that US-guided femoral nerve blocks administered in the ED are a feasible adjunct to parental analgesia in elder patients with acute femoral neck and intertrochanteric fractures. The short time needed to complete the procedure, lack of complications, and single attempt required suggest that physicians with access to bedside US can effectively carry out this procedure in the acute care setting. Emergency department physicians are already adept at other US-guided procedures, such as central venous access, and this study demonstrates US-guided femoral nerve blocks as another procedural skill the emergency physician can use.

In addition, our study findings also suggest that US-guided femoral nerve blocks can provide effective adjunctive pain control in the ED for hip fractures that is sustained over at least a 4-hour period. We know from anesthesiology research that US-guided femoral nerve blocks can be used in the operative setting [7,8]; our study suggests that this can be expanded to the ED.

Although most patients received morphine before the procedure, we do not believe that the pain decrease observed can be accounted for by parenteral morphine administration before the femoral nerve block. Parenteral morphine generally exerts its peak effect 10 to 30 minutes after administration and has a plasma half-life of approximately 90 minutes. All participants underwent the femoral nerve block after the peak effect of morphine, and participants sustained decreased pain scores past the duration of action of morphine. The femoral nerve block had its most dramatic effect between 15 and 30 minutes after the procedure. This effect corresponds with the expected onset of bupivacaine.

We report 100% success in performing the procedure and achieving pain relief in this pilot study. However, the small sample size and use of only 2 operators do not allow us to calculate an estimated success rate of the procedure for all ED clinicians. In addition, the pain response to the procedure was variable. Three subjects achieved and sustained pain scores of 0/10 after US-guided femoral nerve block, but the overall median pain score achieved was 3/10. Variations in operator technique and patient pain perception might account for differences in pain reduction. Another reason why there might be differences in pain reduction between subjects is that the sensory innervations of the hip are also variable. Whereas the femoral shaft and distal epiphysis of the femur are innervated almost exclusively by the femoral nerve, anatomical studies have demonstrated variations in innervations of the hip. The hip receives contributions predominantly from the femoral, obturator, and lateral cutaneous nerves but occasionally from the sciatic and superior gluteal as well [12]. The sciatic nerve and superior gluteal nerve would not be effected by this nerve block. Therefore, our findings that some subjects experienced complete reduction in pain, while others only had a partial reduction, may reflect this anatomic variation between individuals.

In our study, US-guided femoral nerve blocks provided rapid and sustained pain relief with minimal or no adjunct parenteral analgesia. Of 13 of our study participants, 10 did not require any rescue analgesia. Although lack of blinding to the study intervention could potentially influence the practice of the ED physicians in prescribing rescue analgesia, this study finding has particular appealing for elderly patients. The elderly comprise most of patients who sustain hip fractures, and it is well known that elders are particularly susceptible to the deleterious consequences of parenteral opioids, which include respiratory depression and hypotension. The use of opioid medications also has been associated with acute confusional states in the elderly [13]. If we can decrease narcotic use in the elderly by using alternative methods of pain control, we can perhaps reduce the incidence of narcotic-related side effects.

Our study is limited by its small size and lack of randomized controlled design. We cannot calculate overall failure or complication rates of the procedure, and we cannot compare relative effectiveness to narcotic use alone. However, if our preliminary findings can be substantiated in a larger study, it may change the way we approach pain management in elder hip fracture patients in the ED.

5. Conclusion

In summary, this study demonstrates that US-guided femoral nerve blocks are feasible in the ED and highlights that significant and sustained decreases in pain can be achieved with this intervention. Although we cannot make direct comparisons to parenteral analgesia alone, this pilot study suggests that US-guided femoral nerve block is an adjunct, or perhaps an alternative to, parenteral narcotics. Future studies are needed, which compare US-guided femoral nerve block to parenteral analgesia and examine pain reduction, narcotic use, and complications throughout the patient's hospital course.

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