


Original Article

Ultrasound-guided femoral nerve block and intravenous fentanyl in pain management of the patients with hip fracture: a prospective, randomized, single blinded clinical trial

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Aim: Proximal femoral fracture is a painful condition. Pain alleviation is a treatment cornerstone to both comfort the patient and reduce adverse effects. This study aimed to evaluate and compare ultrasound-guided femoral nerve block and intravenous fentanyl administration in relieving the pain of patients with hip fractures.

Methods: The present interventional clinical trial was conducted on 40 patients referred to Shahid-Bahonar Hospital with unilateral isolated proximal femur fracture and American Society of Anesthesiologists I and II. The patients were randomly divided into two groups: intravenous fentanyl and ultrasound-guided femoral nerve block for pain management. Pain severity was assessed by a numerical rating scale before and after the intervention in both groups and the groups were then compared.

Results: Forty patients were enrolled in to study; 27 (67.5%) were male. There was no significant difference in demographic variables between the two groups. Fourteen (35%) were older than 80 years. Pain significantly decreased three scores compared to the pre-intervention level in both groups (95% confidence interval, 2–4). This was slightly higher in the femoral nerve block group. The largest strength of association for age and numerical rating scale of pain was found in the differences between the pre-intervention and after-intervention in femoral nerve block group ($r = -0.775$, $P < 0.001$).

Conclusion: We found similar pain severity between the two groups. Considering the possible side effects of fentanyl, an ultrasound-guided femoral nerve block shows may provide safer pain control and may be particularly suitable for patients with opioid dependence.

Key words: Femoral nerve block, fentanyl, opioids, pain relief, ultrasound

INTRODUCTION

SURGICAL CORRECTION OF the pelvic fracture is one of the most common emergency orthopedic procedures.^{1–3} Almost one-third of the patients with hip fractures

report mild pain, one-third have moderate pain, and the remainder suffers from severe pain at rest. However, over three-quarters of these patients mention moderate to severe pain when moving their fractured limbs.⁴ Opioids are recommended for the management of acute pain.^{5,6} However, their side effects include addiction, nausea and vomiting, urinary retention, itching, lethargy, and respiratory depression.^{5–9} In addition, opioids may cause worse patient outcomes in elderly patients.^{7–9}

Nerve blocking may alleviate the pain and result in reduced need for administration of intravenous analgesics¹⁰; therefore, it may contribute to the postoperative recovery, especially in proximal femoral fractures.^{11,12} Femoral nerve

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block (FNB) is safe, simple, and easy to learn and perform. A recent systematic review of eight clinical trials with 373 participants showed that peripheral nerve block reduced pain almost 30 min later, which was more effective than intravenous analgesic injection.¹³ Given the importance of pain management, the fact that FNB is one of the appropriate methods for pain management following lower extremity surgery and considering the recent advances in ultrasound techniques facilitating the procedures and resulting in fewer adverse events; the present study was performed to investigate and compare ultrasound-guided femoral nerve block with intravenous fentanyl in pain management of the patients with hip fractures.

METHODS

Study design and setting

A PROSPECTIVE RANDOMIZED single blinded clinical trial (IRCT20171009036661N4) was conducted at emergency department (ED) of Shahid Bahonar Hospital, the only trauma center in Kerman from September 1, 2015 to November 1, 2015. Patients with unilateral isolated proximal femur fracture and American Society of Anesthesiologists (ASA) I and II referred to ED were included. Additionally, patients with allergy to amide local anesthetics, peripheral neuropathy, previous block at the affected site, mental disorders, risk of hemorrhage, other concomitant fractures and a history of fracture at the same site, diabetics, and patients who did not mention having pain were excluded.

Sample size estimation

Sample size measurement was done based on the study performed by Fletcher *et al.*¹⁴ The mean in population 1 in numerical rating scale (NRS) was 2.5 with standard deviation (SD) of 1.5 and in population 2 was 3.8 with SD of 0.6. Therefore, taking α error at 0.05 and power at 80%, the calculated minimum sample size was 13 in each group. For possible dropouts, we studied 20 patients in each group.

Intervention

Patients were randomly divided into two groups by random allocation sequence with SAS statistical software (version 9.1, SAS Institute Inc., Cary, NC, USA). According to this method, a simple randomization list is produced and patients involved in each group are determined based on their order of entry to the ED. We used sequentially numbered, sealed, opaque envelopes for allocation concealment. Patients

(individuals) were the randomization units. Moreover, the outcome assessor was blinded, as the sedation procedure and sonography was performed by the main investigator in an isolated room. The data analyzer was also blinded because all the checklists were anonymous and contained only a code.

Both groups were evaluated for NRS criteria (0–10) half an hour before interventions. Participants in the control group received intravenous fentanyl at a dose of 1.5 $\mu\text{g}/\text{kg}$ stat. The intervention group (FNB) was evaluated by NRS approach followed by an injection of 20 mL of 2% lidocaine solution guided by ultrasonography. This procedure was done by an emergency physician who had a point-of-care ultrasound certificate. The patients were initially placed in the supine position and the injection site was marked about 1 cm distal to the femoral artery and 3 cm inferior to the inguinal ligament. After prep and local anesthesia (with insulin syringe and 1 cc of lidocaine 2%), 20 cc of xylocaine 2% was injected into the site using a 7.5-MHz probe under ultrasound guidance. During injection, the nerve sheath expansion with lidocaine entry was observed in the monitor. A 24-G needle was inserted vertically three centimeters away, parallel to the femoral artery. After the aspiration test was negative, 2 mL of the anesthetic was injected as a test dose. The infusion was performed after 30 s of cardiac and blood pressure monitoring if there were no signs of abnormal cardiac rhythm. Hand pressure was applied distal to the region to guide the fluid toward the cephalic direction. During the procedure, blood pressure, heart rate, respiratory rate, and arterial oxygen saturation were measured. Eventually, pain scores were assessed at 15 min after intervention in both FNB and intravenous fentanyl injection groups.

Outcomes

Pain severity was the main outcome and was determined using the NRS as a conventional method of pain assessment, which has been proved to be reliable and not affected by gender. Accordingly, on the ruler marked from 0 to 10, the patients marked their own pain level, indicating 0 as no pain and 10 as the most severe pain to be imagined. To obtain more reliable responses, the patients were asked to pay attention to the classification when marking their pain level.

Statistical analysis

Continuous data was expressed as median and interquartile range [IQR] depends on distribution of data applying Kolmogorov–Smirnov test. The non-parametric categorical values of pain severity were analyzed using Mann–Whitney *U*-test for independent groups of pain score. A Wilcoxon

signed-rank test applied to see the reduction in pain severity after intervention in each group. χ^2 test was used to analyze differences in baseline characteristics including categorical variables (sex, age, and the site of fracture) between the two groups. Pearson correlation coefficient was done to measure the strength of linear association between age and NRS before and after intervention and the difference in scores (NRS1-NRS2). Data were analyzed by statistical package for social sciences (SPSS) for windows, version 21.0 (IBM, Armonk, NY). Using non-parametric tests for pain severity, Monte Carlo 95% confidence intervals (95% CI) were calculated through NRS, and a two-tailed P -value < 0.05 was considered statistically significant. The sum of pain severity ranks was calculated for each group. Odds ratio (95% CI) applied for sex and fracture site to see the risk among studied groups.

RESULTS

A TOTAL OF 58 patients with unilateral isolated proximal femur fracture referred to the ED of our hospital were evaluated, eight of whom did not consent to be enrolled; three had coagulation disorders, five had diabetic neuropathies, and two had advanced heart failure and were excluded. The remainder 40 were included into the study and randomly allocated. All of them finished the study. As shown in Table 1, there was no significant difference in demographic variables between the two groups, indicating homogeneity between them ($P > 0.05$). The age range was 19 to 95 years old; median [IQR] age range was 73 [56, 85]. Our results showed that the median [IQR] pain severity was

similar before the therapeutic measures in both groups (7 [6, 9] [range, 5, 10] vs. 7 [6, 8] [range, 5, 10]).

Applying Wilcoxon signed-rank test, compared to pre-intervention level, pain had significantly decreased in both groups (95% CI median difference, -1 to 1 , $P < 0.001$) (Table 2). This was slightly higher in the FNB group. Table 3 compares the pain level in the intravenous fentanyl and FNB groups based on gender. As shown, gender had no effect on the pain severity before and after the intervention.

Pearson's correlation analysis showed a negative association of age with NSR1 ($r = -0.483$, $P = 0.002$) and NSR1-NSR2 ($r = -0.654$, $P < 0.001$). After splitting the group, the largest strength of association between age and pain scores was among NSR1-NSR2 in FNB group ($r = -0.775$, $P < 0.001$). Figure 1 shows matrix scatter of whole study and the simple scatter of NSR1-NSR2 associated with age.

No patient in either group experienced hypotension, lethargy, hypoxia, and depressed respiratory rate following intervention. However, two patients and five patients in the intravenous fentanyl injection group reported pruritus and nausea/vomiting, respectively.

DISCUSSION

IN BONE FRACTURES, effective analgesia makes primary rehabilitation easier, shortens the length of hospital stay, and reduces the overall cost of health care.^{14,15} According to the high prevalence of opium addiction in our community, consideration of alternative methods, except for intravenous administration of analgesics, is important. Therefore, the present study was performed to investigate

Table 1. Demographic characteristic of the two study groups

Variable	Groups in study		Total ($n = 40$)	95% CI	Median differences with 95% CI†
	Fentanyl IV injection ($n = 20$)	Femoral block ($n = 20$)			
Gender					
Female n (%)	8 (40)	5 (25)	13 (32.5)	50.9–	–
Male n (%)	12 (60)	15 (75)	27 (67.5)	81.4 [‡]	
Median [IQR], age (min, max)	74 [59, 87], (36, 95)	70 [38, 85], (19, 92)	73 [56, 85], (19, 95)	61–80	0 (–12 to 7)
Site of fracture					
Inter-trochanteric n (%)	16 (80)	16 (80)	32 (80)	64.4–	–
Femoral neck n (%)	4 (20)	4 (20)	8 (20)	90.9 [‡]	

IQR, interquartile range; IV, intravenous.

[†]The probability of being male is used as the reference; $P = 0.04$.

[‡]The probability of inter-trochanteric fracture is used as the reference; $P < 0.001$.

Table 2. Comparing pain scores in the study groups

Scoring	Groups in the study		Total median with 95% CI (n = 40)	Median differences with 95% CI
	Fentanyl IV injection (n = 20)	Femoral nerve block (n = 20)		
Median [IQR] NRS1 (min, max)	7 [6, 9] (5, 10)	7 [6, 8] (5, 10)	7 (7–8)	0 (0–1)
Median [IQR] NRS2 (min, max)	4 [4, 5] (3, 8)	4 [3, 5] (2, 6)	4 (4–5)	0 (0–1)
Median [IQR] NRS1-NRS2 (min, max)	2 [2, 4] (1, 5)*	4 [2, 5] (1, 6)*	3 (2–4)	0 (–1 to 1)**

Data showed with median [IQR] (min, max), NRS1: before intervention, NRS2: after intervention. * $P < 0.001$, ** $P = 0.011$. IV, intravenous; IQR, interquartile range; NRS, numerical rating scale.

Table 3. Comparison of pain in the in the FIVI vs. FNB group by gender

Scoring	Group	Sex	
		Female (n = 13)	Male (n = 27)
Median [IQR] NRS1 (min, max)	FIVI	7 [6, 9] (5, 9)	8 [6, 10] (5, 10)
	FNB	7 [6, 9] (5, 10)	8 [7, 8] (6, 10)
Median [IQR] NRS2 (min, max)	FIVI	4 [4, 4] (3, 7)	5 [4, 6] (3, 8)
	FNB	4 [3, 6] (2, 6)	4 [3, 5] (2, 6)
Median [IQR] NRS1-NRS2 (min, max)	FIVI	3 [2, 4] (1, 5)	2 [2, 3] (1, 5)
	FNB	2 [1, 5] (1, 5)	4 [4, 4] (1, 6)
Median differences with 95% CI	FIVI	0 (–1 to 1)	–1 (–1 to 0)
Median differences with 95% CI	FNB	–1 (–2 to 2)	1 (1 to 1)

FIVI, Fentanyl IV Injection; FNB, femoral nerve block; IQR, interquartile range; NRS, numerical rating scale. Data are median [IQR] (range).

and compare ultrasound-guided femoral nerve block with intravenous fentanyl on the pain level of patients with hip fracture. The findings of the present study indicated that the pain intensity of the patients before the intervention was not significantly different. Moreover, the pain intensity after the intervention was similar between the two groups, but decreased significantly compared to the pre-intervention level. This level was higher in the fentanyl group, but with an insignificant difference. Iamaroon and colleagues¹⁶ examined 64 patients ages 18 to 80 years with femoral fractures, randomly divided into FNB and fentanyl groups. There was no significant difference in the pain scores between the FNB and intravenous fentanyl groups,¹⁶ which is in line with the results of the present study. Reddy *et al.*¹⁷ compared the efficacy of FNB and intravenous fentanyl for positioning in hip fracture surgery and reported that FNB was significantly better suited for positioning than intravenous fentanyl with a lower visual analogue scale score.

Mosaffa *et al.*¹⁸ investigated the pain level of 20 patients with femoral shaft fracture using FNB and intravenous fentanyl methods. Their findings showed that the fascia iliaca block resulted in higher levels of analgesia. Similarly, Dolatabadi and colleagues¹⁹ studied patients with femoral shaft fracture who were divided into two groups of morphine and FNB. The pain severity was assessed by NRS on admission and 5 min, 1, 2, and 3 h, thereafter. The results showed that the FNB group had significantly lower pain scores.¹⁹ Jadon *et al.*²⁰ compared FNB and intravenous fentanyl methods in the femoral fracture surgery. According to the reported results, the NRS values were significantly less in the FNB group. In the present study, statistically significant (but weak) difference was reported between the fentanyl and FNB groups (Table 2). Although both intravenous fentanyl and FNB methods were effective in relieving pain, FNB is a better option because it has no side effects of opioid injections especially when performed by ultrasonography

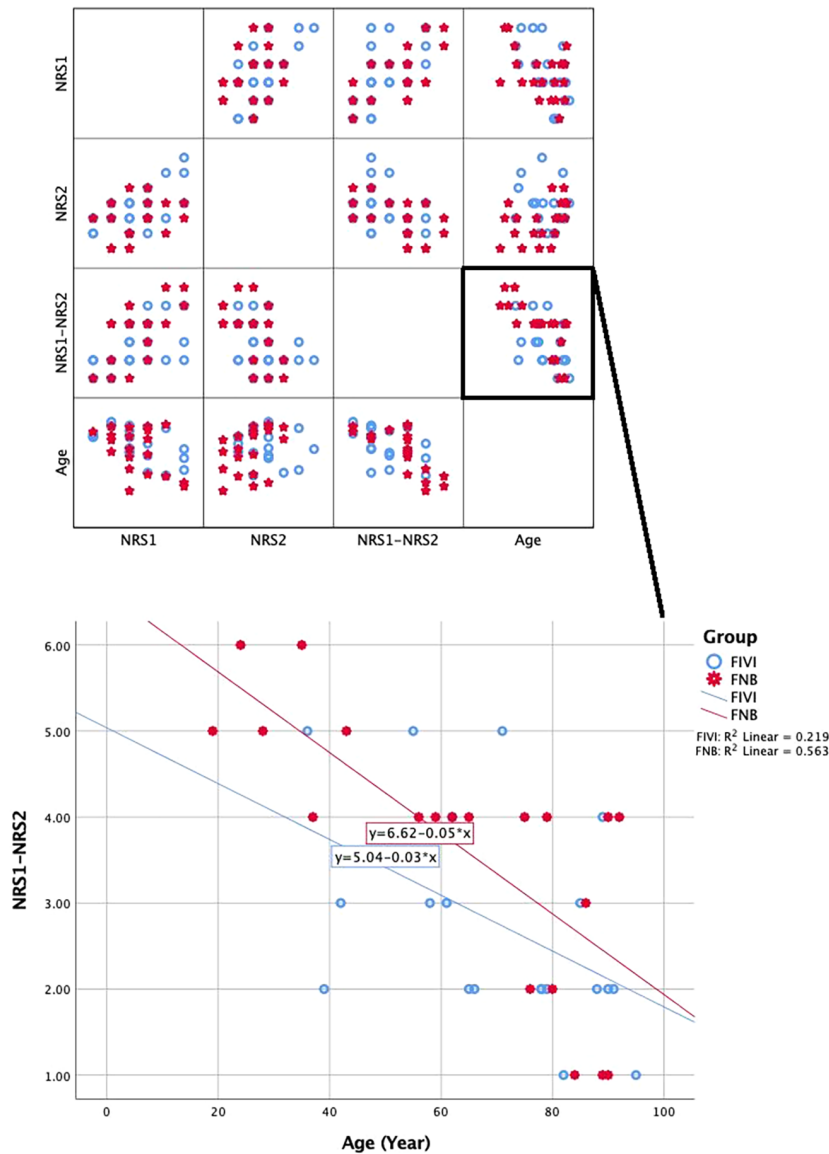


Fig. 1. Matrix scatter and simple scatter of NSR1-NSR2 in femoral nerve block (FNB) and intravenous fentanyl injection (FIV) (n = 40).

guidance. Finally, among the demographic variables, age was the only factor that influenced the severity of pain, which might be because of the lowered pain tolerance threshold in people as they age.

Study limitations

Our small sample size and limited duration of reassessment were our main limitations. We recommend a study with a larger sample size and a longer follow-up period in the future.

CONCLUSION

BOTH FNB AND intravenous administration of analgesics alleviate pain because of hip and intertrochanteric fractures similarly. Therefore, using both methods is recommended in the ED and in the operating room. Among the demographic factors, age can affect the severity of the pain of the patient reports before and after intervention in FNB group. According to the high rate of opium addiction in our city and possible side effects of fentanyl, FNB may be an effective alternative method in patients with

high risk factor of opium use, which may reduce the need for opium use and possible adverse reactions.

ETHICAL APPROVAL

The protocol of this study was reviewed and approved by Ethics Committee of Kerman University of Medical Sciences (ethics number: IR.KMU.REC.1394.373).

DISCLOSURE

APPROVAL OF RESEARCH Protocol: The protocol was approved by the institutional review board of Kerman University of Medical Sciences.

Informed Consent: Written informed consent was obtained before intervention and written informed consents were obtained from all participants.

Registry and the Registration No. of the Study/Trial: IRCT20171009036661N4. Registered June 17, 2020—Retrospectively registered, <https://www.irct.ir/trial/48426>

Animal Studies: N/A.

Conflict of Interest: None declared.

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