



The comparison of postoperative analgesic efficacy of three-in-one-block versus fascia-iliaca blocks following femoral fracture orthopedics surgical procedures under spinal anesthesia, Gondar, Ethiopia, 2021: A prospective cohort study

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Abstract

Introduction Femoral bone fracture is the predominant, lower limb orthopedic surgery that is associated with severe acute and persistent chronic pain that needs better postoperative pain management. Untreated postoperative pain results inability to do physiotherapy resulting in stiffens of joints and immobility. This study aimed to compare the postoperative analgesic efficacy of three-in-one-block versus fascia iliaca block in patients who underwent surgically treated femoral fractured patients under spinal anesthesia.

Methods A prospective cohort study was conducted on 110 elective surgically treated femoral fractured orthopedic patients from January to October 2021. Data were entered into epi-data 4.4.2 and imported into a statistical package of social science version 22 for analysis. Shapiro–Wilk normality test was used to check the normality of the data and normally distributed data were analyzed using Student’s independent t-test, whereas non-normally distributed variables were analyzed with Mann–Whitney *U*-test. The comparisons of categorical parameters were analyzed using the chi-square test and Fisher’s exact test. Finally *p*-value < 0.05 was declared to be statistically significant.

Result The median and interquartile range of the postoperative numerical rating scale at rest and on movement was significantly less in three-in-one-block (3IN1B) as compared with fascia-iliaca block (FICB). But at 30 min no significantly different between the two pain management modalities. Moreover, the meantime to seek the first request of analgesia was significantly prolonged in 3IN1B compared with FICB. Regarding the total analgesic consumption, the mean total tramadol consumption was 97.27 ± 53.07 and 180 ± 72.96 ($p < 0.001$) and Diclofenac 53.18 ± 29.28 and 72 ± 43.54 ($p < 0.001$) in 3IN1 and FICB, respectively.

Conclusion The present study concludes that three-in-one-block provides more effective analgesia, reduced postoperative analgesic requirements, and prolonged first analgesics requests compared with fascia iliaca block, and Landmark technique fascia-iliaca block (FICB) is an alternative pain management modality in a resource-limited setting.

Keywords Three-in-one-block · Fascia-iliaca block · Analgesic efficacy

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Abbreviations

FICB	Fascia iliaca block,
3IN1B	Three-in-one-block
NRS	Numerical rating scale

Introduction

A road traffic accident is the most common cause of fracture, and the femoral bone fracture was the predominant [1]. Orthopedic surgery is associated with severe acute pain and persistent chronic pain with an incidence of 70.5% in the study area [2], [3], which shows pain associated with postoperative orthopedic surgery is not treated adequately. Practicing a better pain management strategy is one of the most common postoperative cares in orthopedics surgical procedures, and untreated pain results in inability to do physiotherapy, stiffness of joint immobility [4, 5], delayed wound healing, hemodynamic disturbance, transition to chronic pain [6], increased financial costs, prolonged hospital stay, increased morbidity and mortality risks [7]. Therefore, postoperative pain management after femoral fractures is very important for early mobilization, prevention of complications, and restoration of function [8]. However, systemic opioids are commonly prescribed to relieve postoperative pain following an orthopedic surgical procedure, it lasts a longer time as compared with other surgery, and requires repeated doses of opioids which leads to addiction. So regional block is alternative pain management that avoids opioid-related complications [9, 10]. Among those regional blocks epidural [11, 12], posterior, and anterior psoas compartment blocks (three-in-one-block and fascia-iliaca blocks) [13] are widely used as the peripheral nerve block pain management options for surgery of the femoral hip, thigh, and knee surgical procedures [14].

Fascia iliaca and three in one block are commonly performed through blind technique, nerve stimulator based, or ultrasound guide [15]. The success rate of nerve blocks with the blind technique is lower as compared with nerve stimulators and ultrasound approaches [16]. Even though, blind techniques and nerve stimulators are commonly performed in the study areas; the ultrasound-based which has a high success rate is not available due to resource constraints.

Both fascia iliaca and three-in-one-block are targeting femoral, obturator, and lateral femoral cutaneous nerves by a single injection of a local anesthetic drug with different technical approaches [17].

Limited studies are comparing the analgesic effectiveness of three-in-one-block and fascia iliaca compartment blocks and are inconclusive regarding the effectiveness [18–21]. So this study aimed to compare the two commonly performed techniques in postoperative analgesic efficiency, success rates, and first analgesic request of three in one versus fascia

iliaca block in patients who underwent surgically treated femoral fractured patients under spinal anesthesia.

Methods

Study design, study area, and period

An institutional-based prospective cohort study design was conducted on 110 surgically treated femoral fractured patients' at University of Gondar comprehensive specialized hospital from January to October 2021, which is one of the largest hospitals in Amhara regional state, Ethiopia.

Ethical clearance was obtained from University of Gondar School of medicine ethical review board and written informed consent was obtained from each study subject, after disclosing the aim of the research, and the risk and benefits of the procedures. In addition, participants were informed that they had a full right to stop the interview at any time during data collection.

Source and study population

Source population: All elective surgically treated femoral fractured patients under spinal anesthesia at the University of Gondar comprehensive specialized hospital.

Study population: All elective surgically treated femoral fractured patients under spinal anesthesia at the University of Gondar comprehensive specialized hospital having three-in-one-block or fascia-iliaca block.

Sampling population:—All elective surgically treated femoral fractured patients under spinal anesthesia at the University of Gondar comprehensive specialized hospital having three-in-one-block or fascia-iliaca block within the study period.

Inclusion and exclusion criteria

All adult elective surgically treated femoral fractured patients under spinal anesthesia with bupivacaine and who took either fascia-iliaca compartment block (FICB) or three-in-one-block following surgery. While any preoperative sensory loss of either obturator, femoral or lateral femoral cutaneous nerves, patients less than 18 years, discharged before 24 h, patients who refused to be included in the study, history of chronic pain, and multiple fractures were excluded.

Variables of the study

Dependent variables: Analgesic efficacy of three-in-one-block vs fascia-iliaca block (level of pain, both at rest and on movement, time to request 1st analgesia, and total analgesic consumption within 24 h following the block).

Independent variables: sociodemographic variables (age, sex, weight, BMI), preoperative analgesia intake, preoperative pain severity, the volume of bupivacaine for spinal anesthesia, BROMAGE scale, duration of the procedure, and type of regional block.

Sample size calculation

Since there was no similar published study in Ethiopia regarding the comparison of three-in-one-block vs fascia-iliaca block with bupivacaine, we have conducted a pilot study to determine the sample size, but the sample size in the pilot study was smaller than the sample size in the previous study (success rate of the three-in-one-block and fascia-iliaca block were 50% and 80%, respectively), so the sample size was determined based on a previous study [7] with the double population proportion formula (N);

$$N = \frac{p_1(1-p_1) + p_2(1-p_2)}{(P_2 - P_1)^2} \times f(\alpha, \beta)$$

$$N = 49.4 = 50$$

Assuming a 10% none response rate = 55 in each group. $f(\alpha, \beta) = 10.85$ for 90% power with 5% margin of error. $p_1 = 0.5$ (success rate of three-in-one-block). $p_2 = 0.8$ (success rate of FICB).

Anesthesia protocol, Data collection procedure, sampling technique, and quality control

According to the hospital protocol, elective Patients are scheduled a day or two days before a surgical procedure in orthopedic patients for anesthesia evaluation and optimization. The three-in-one-block with a nerve stimulator and fascia-iliaca block as a landmark technique is the most commonly performed block after surgically treated femoral fractured patients under spinal anesthesia for postoperative pain management with the responsible senior anesthetist (Masters and Above). Before entering the operation theater, informed consent was obtained from each study subject after disclosing the risk and benefits of the study. Before spinal anesthesia, 4 mg dexamethasone is protocolled as pre-medication for adult elective surgical patients, and at least minimum American Society Anesthesiologist (ASA) standard of monitoring (pulse oximetry, electrocardiograph, and non-invasive blood pressure monitoring) was attached. Then with aseptic techniques, spinal anesthesia was given and the sensory was assessed with a pinprick while the motor was assessed using a modified BRMAGE scale. The BRMAGE scales are 0 = No motor block, 1 = Unable to raise an extended leg (able to flex the knee), 2 = Unable to flex the knee (able to

move the foot only), 3 = Unable to flex the ankle (unable to move the foot or knee).

Trained data collectors were collecting data with semi-structured questionnaires adopted from previous studies and surgically treated femoral fractured patients under spinal anesthesia having either three-in-one-block or FICB with the independent decision of the responsible senior anesthetist were included in this study. Regarding the techniques of those regional blocks, all patients were in a supine position and the skin was cleaned aseptically in both groups. A three-in-one-block was performed in a supine position with landmark techniques of 1.5 cm below the inguinal ligament and 1.5 cm lateral to the femoral artery which is supported by scientific backgrounds. The needle was inserted perpendicular to the skin and after obtaining sustained contraction of femoral quadriceps muscle at 0.5 milliamperes, a single-shot 30 ml of 0.25% bupivacaine was deposited. While FICB was performed with the landmark technique, the inguinal ligament was identified and the femoral artery was palpated, then the needle was inserted perpendicular to the skin at a point 1 cm below the juncture of the lateral and medial two-thirds of a line that joins the pubic tubercle to the anterior superior iliac spine. The needle was inserted until a loss of resistance was felt as the fascia Lata was passed, and further advanced until the second loss of resistance occurred when the fascia iliaca was pierced (often described as two “pops”). With an attached syringe, the first aspiration was performed to exclude intravascular injection, after that 30 ml of 0.25% bupivacaine was given [22]. Non-probability convenient sampling was used and an equal number of patients were selected in both groups until the calculated sample size was fulfilled.

Regarding the data collection technique, the responsible senior anesthetist did either of the blocks and the investigator who stayed in the operation theater during the regional block put a specific code on the patient card. One of the data collectors was responsible for the recording of preoperative and intraoperative variables, while the other was recorded in the postoperative period until 24 h in collaboration with the responsible nurses in the post-anesthesia care unit and orthopedic wards. The data collectors were blind to the type of regional block. Moreover, investigators and data collectors had no power to decide or interfere with any type of block. The investigators were checking the data quality throughout the study period.

Efficacy is a measurement of severity of pain, time to seek 1st analgesia request, and total analgesic consumption between the two groups [23]. The severity of pain at 30 min, 1, 2, 4, 6, 12, and 24 h assessed through a numerical rating scale (NRS) was the primary outcome, while both times to seek 1st analgesia and total analgesic consumption were the secondary outcomes within 24 h, and patients were also informed that they need to inform assigned health

professionals to have analgesia if they feel pain and this time was considered as the first analgesia request.

Data analysis and interpretation

Data were entered into epi-data 4.4.2 and imported into SPSS version 22 for analysis. Both descriptive and inferential statistics were used and the results were presented using Tables, and texts. Shapiro–Wilk normality test was used to check the normality of the data and normally distributed data were analyzed using Student's independent t-test then the result was presented as mean \pm SD (standard deviation), whereas non-normally distributed variables were analyzed by Mann–Whitney *U*-test, and the result was expressed as median and (interquartile range). The comparisons of categorical parameters were analyzed using the chi-square test and Fisher's exact test as required and expressed in numbers and percentages. Finally, *P*-value < 0.05 was declared to be statistically significant.

Result

Socio-demographic variables

A total of 110 patients were involved in this study with equal allocations in both three-in-one-block and FICB. In this study patients' age ranges from 18 to 58 years with a mean and standard deviation of 33. 85 \pm 12.02 years. The socio-demographic variables and severity of preoperative pain were comparable between groups as shown in (Table 1). The median and IQR of preoperative pain through the numerical

rating scale (NRS) at rest were 3 (2–4) and 2 (1–4) between 3IN1 and FICB, respectively, while preoperative pain through the numerical rating scale (NRS) at movement was 5 (5–6) and 5 [3–7] between 3IN1 and FICB, respectively, as shown in (Table 1). In this study, the most practiced surgical treatment of femoral fracture was intramedullary nailing which accounts for 69%, and 56% of three-in-one-block and fascia iliaca blocks, respectively (Table 2).

The median and interquartile range (IQR) of the postoperative numerical rating scale (NRS) at rest and on movement were significantly less in three-in-one-block as compared with fascia iliaca block (FICB) but at 30 min not significantly different between the two groups (Table 3 and 4).

The mean time to seek 1st request of analgesia was 11. 63 \pm 2.13 and 8.64 \pm 2. 26 in three in one block (3IN1) (*p* < 0.001) and fascia-iliaca compartment block (FICB),

Table 2 Pattern of surgical treatment for femoral fractured patients under spinal anesthesia and postoperative pain management with three-in-one-block and fascia iliaca block, 2021 (*N* = 110)

Type of operation	3IN1B (<i>n</i> = 55)	FICB (<i>n</i> = 55)
Plating	3	2
Anterograde IMN	15	12
Retrograde IMN	23	19
IMN correction	2	3
EX-fix	3	4
Femoral neck fixation	3	5
ORIF	7	6
Sequestrectomy	1	2

ORIF (open reduction and internal fixation), EX-fix (external fixation), IMN (intramedullary nailing)

Table 1 Sociodemographic and perioperative variables in comparing the analgesic efficacy of three-in-one-block versus fascia iliaca block following surgically treated femoral fractured patients under spinal anesthesia 2021 (*N* = 110)

Character	3IN1B (= 55)	FICB (= 55)	<i>p</i> -value
Age (years)	32.27 \pm 11.20	36 \pm 12.90	0.07
Sex (Male/Female)	41/14	46/9	0.24
Height (cm)	171.32 \pm 6.01	170.24 \pm 6.06	0.35
Weight (kg)	60.36 \pm 9.32	63.45 \pm 8.31	0.07
BMI (kg/m ²)	20.69 \pm 3.09	21.58 \pm 2.14	0.08
ASA (I/II)	24/31	28/27	0.70
Mean tramadol in 24 h before SA	95.4 \pm 2.5	87.1 \pm 3.5	0.08
Mean diclofenac in 24 h before SA	68 \pm 4.8	73.8 \pm 2.92	0.06
Pre-op NRS at rest	3(2–4)	2(1–4)	0.18
Pre-op NRS at on movement	5(5–6)	5(3–7)	0.19
Spinal dose (ml)	3.35 \pm 0.31	3.49 \pm 0.43	0.06
BROMAGE scale of SA 2	11	8	0.8
BROMAGE scale of SA 3	44	47	0.6
Duration of surgery (hr.)	2.58 \pm 0.88	2.30 \pm 0.85	0.07
Duration of SR of SA after the operation	1.9 \pm 0.9	2.01 \pm 0.86	0.09

SA (spinal anesthesia), NRS (numerical rating scale), ASA (American Society of anesthesiologist), BMI (body mass index)

Table 3 postoperative level of pain through numerical rating scale (NRS) at rest between three-in-one-block and fascia iliaca block, 2021 ($N=55$)

Postoperative time	3 IN B($n=55$)	FICB($N=55$)	<i>P</i> -value
½ hour	0(0–0)	0(0–1)	0.09
1 h	0(0–0)	1(0–2)	<0.001
2 h	1(0–1)	1(0–2)	<0.001
4 h	1(0–1)	2(1–3)	<0.001
6 h	1(1–2)	2(2–4)	<0.001
12 h	1(1–2)	3(2–4)	<0.001
24 h	2(1–2)	3(3–4)	<0.001

Table 4 postoperative level of pain through numerical rating scale (NRS) on movement (passive leg extension and flexion during physiotherapy) between three-in-one-block and fascia iliaca block, 2021 ($n=55$)

Postoperative time	3 IN B($n=55$)	FICB($N=55$)	<i>P</i> -value
½ hour	0(0–0)	0(0–1)	0.08
1 h	1(0–1)	2(0–2.5)	<0.001
2 h	1(0–1)	2(1–3)	<0.001
4 h	1(0–2)	3(2–3)	<0.001
6 h	2(0–2.5)	4(2–5)	<0.001
12 h	3(2–4)	4(3–5)	<0.001
24 h	3(3–4)	4(4–5)	<0.001

respectively. The mean total tramadol and *diclofenac* consumption was significantly lower in 3IN1B as compared with FICB. Thus, the mean total tramadol consumption was 97.27 ± 53.07 and 180 ± 72.96 ($p < 0.001$) in 3IN1 and FICB, respectively, whereas, the mean *Diclofenac* consumption was 53.18 ± 29.28 and 72 ± 43.54 ($p < 0.001$) in 3IN1 and FICB, respectively. Regarding postoperative adverse events, four patients in fascia-iliaca block developed postoperative nausea and vomiting, while one patient in 3IN1B developed vomiting.

Discussion

The present study was designed prospectively to compare the analgesic efficacy of three-in-one-block with FICB for femoral fracture orthopedic procedures under spinal anesthesia. This study concludes that there were no statistically significant differences between the 3IN1 block and FICB blocks using the numerical rating scale (NRS) both at rest and on movement in the first 30 min of the postoperative period. But there was a significant statistical difference between the 3IN1 block and FICB blocks using both at rest and on movement in 1, 2, 4, 6, 12, and 24 h of the postoperative period.

Tramadol and diclofenac are commonly prescribed for postoperative pain management in the study setting were significantly reduced in total consumption and a prolonged time for the first analgesics request of three-in-one-block as compared with FICB. The current finding is supported by a study in France regarding the analgesic efficacy of 3IN1block using a nerve stimulator and FICB without a nerve stimulator showed that the distributions of sensory block were significant in 3IN1 block compared with FICB. But There was no significant difference appreciated regarding median visual analog scale (VAS) pain score values and consumption of analgesics between the two groups which may contradict the current result [19]. The possible explanations might be the previous study was conducted with continuous catheter-based with ropivacaine under general anesthesia, the difference in the pain assessment tool. Another study on emergency femoral neck fracture stated that there was no significant difference between three-in-one-block and FICB at 60 min after the block [20] in the postoperative period [24, 25] the possible reason might be the current study includes all femoral fractures.

The present study is also contradicted by a study finding in Turkey comparing the analgesic efficacy of three-in-one-block and FICB showed that there was a decrease in NRS score and opioid consumption in both groups and no side effects like nausea and sedation were observed [18]. These comparable analgesic efficacies might be due to ultrasound-based practice between two groups. But in the current study, FICB was with the landmark technique while three-in-one-block was with a nerve stimulator which might affect the quality of block in FICB. In this study, the meantime to 1st analgesia request in FICB was 8.64 ± 2.26 which is more or less similar to the previous studies 6.95 ± 1.87 h [26].

A study in France showed that complete sensory blockade of the femoral nerves was obtained in 90% using the three-in-one-block approach and 88% in FICBs. The Obturator nerve block was got in 52% in three-in-one-block and 38% in FICB. The genitofemoral nerve block was obtained in 38% and 34% of cases both in three-in-one-block and FICB, respectively. The lateral femoral cutaneous nerve block was obtained in 62% in three-in-one-block and 90% in FICB [25], but in the current study, those nerves did not assessed post regional block due to spinal anesthesia.

Another randomized control trial in Austria showed that the onset of time for the sensory block was significantly shorter among patients done under ultrasound-guided techniques of three-in-one-block compared with nerve stimulator approaches [16 vs. 14 min]. Based on this study the quality of sensory block was significantly better in the ultrasound group compared with the nerve stimulator groups (95% vs. 85%) [27]. However, a study done in France showed that fascia iliaca compartment block was obtained a 90% success rate, which is defined as a complete block of the three

target nerves, whereas the success rate in the three-in-one-block group was only 12% [24]. In contrary to the above report, another study in France also showed that the rate of sensory blockage in three in one block was 38% compared with fascia iliaca compartment block, which was 34% [25]. The overall previous studies showed there was controversy regarding the postoperative analgesic efficacy of fascia iliaca block and three-in-one-block.

The results of the present study are also supported by a study in Island regarding the comparison of the three-in-one-block and opioid-based analgesia group, which showed that three-in-one-block significantly decreased the amount of rescue analgesia, reduced pain intensity over 4 h, and no appreciable difference in adverse events when compared with opioid bases analgesia alone for lower extremity fractures [28], and another study in the UK on 100 orthopedics patients showed that patients receiving three-in-one nerve blocks recorded a faster time to reach the lowest VAS pain score: 2.88 h for patients with a nerve block and 5.81 h for control patients (mean difference -2.93 h; 95% CI -5.48 to -0.38 h). Orthopedics surgical patients who received three-in-one-block showed significantly less opioid requirement per hour than control patients (mean of 0.49 mg/h versus 1.17 mg/h; mean difference -0.68 mg/h; 95% CI -1.23 to -0.12 mg/h) [29].

Limitation of the study

The three-in-one block was done with a nerve stimulator but, the fascia-iliaca block was done with the landmark technique.

Even though, the patients were comparable between three-in-one-block vs fascia iliaca blocks were not randomized.

Three-in-one-block and fascia iliaca block was not done by a single anesthetist so, may have inter-individual practical differences that might affect the outcome.

The pandemic of COVID-19 might affect communication between data collectors and patients.

Conclusion

The present study concludes that three-in-one-block provides more effective analgesia, reduced postoperative analgesic requirements, and prolonged first analgesics requests compared with fascia iliaca block, and Landmark technique fascia iliaca block (FICB) is an alternative pain management modality in a resource-limited setting.

Authors' contributions All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Declarations

Conflict of interest The authors declare that there is no conflict of interest.

Ethics approval and consent to participate Ethical approval was granted with University of Gondar, School of Medicine Ethical Review Board, and written consent was obtained from each study subject.

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