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Effects of Perioperative Fascia Iliaca Compartment Block on Postoperative Pain and Hip Function in Elderly Patients With Hip Fracture

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Abstract

Purpose: Pain management is a challenging issue in elderly patients with hip fracture. Despite the accepted clinical outcomes following hip surgery, pain and prolonged recovery time are the most difficult consequences associated with the rehabilitation process. The purpose of this study was to evaluate pain relief and functional improvement associated with the Fascia Iliaca Compartment Block (FICB) during the perioperative period of elderly patients with hip fracture. **Patients and methods:** This study included 120 elderly patients with hip fracture, who were admitted to our institution between January 2019 and December 2020. The participants were subsequently randomly divided into the routine analgesia (RA) and fascia iliaca compartment block (FICB) groups. Inter-group differences were compared via VAS scores at rest and during movement, Harris hip scores (HHS), presence of complications, adverse events after surgery, and length of hospital stay. **Results:** The FICB group VAS scores at rest at 6 hour, 1 and 3 days, and 1 week after surgery were significantly lower than the RA group ($P < .05$). Moreover, the FICB group VAS scores with movement were markedly lower at 6 hour, 1 and 3 days, as well as 1 and 2 weeks after surgery ($P < .05$). The HHS of the FICB and RA groups were (53.41±8.63) and (40.02±9.61), respectively, on the seventh day after surgery, and the difference was statistically significant ($P < .05$). The incidence of postoperative complications and adverse events in the FICB group were not statistically different from the RA group. The average hospital stay of the FICB group was 2.12 days shorter than the RA group, but the difference did not reach statistical significance ($P = .13$). **Conclusion:** FICB provides superior analgesic effect both at rest and with movement, along with rapid short-term recovery of hip function following surgery in elderly patients with hip fracture, without increasing postoperative complications or adverse events.

Keywords

fascia iliaca compartment block, hip fracture, functional recovery, pain relief

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Introduction

Hip fracture is one of the most common fracture types in elderly patients with osteoporosis, and its incidence increases with aging. It is estimated that there are more than 1.6 million new hip fracture patients in China every year.[1] The disability rate of hip fracture is relatively high, and the mortality of patients one month and one year after surgery can be "10% and 36%."[2] With an increasingly aging population, elderly hip fracture, at present, is a global public health problem, jeopardizing physical and mental health, as well as quality of life.

Current guidelines suggest, such patients should receive surgery as soon as possible, even within 24-48 hours after injury. Early treatment can reduce pain and increase surgical success.[3,4] Approximately 70% of patients are in poor health,[5] which restricts the use of opioid analgesics and increases risk of surgery. Surgery is often delayed due to patients taking oral anticoagulation or waiting for a comprehensive systemic exam.[6] Severe postoperative pain not only affects rehabilitation but also increases the risk of postoperative complications.[7]

In recent years, enhanced recovery after surgery is common in surgical procedures. This leads to an increased focus on perioperative pain management. The iliac fascia space is a potential space between the iliac fascia and iliopsoas muscles. It houses the femoral nerve, obturator nerve, and lateral femoral cutaneous nerve, which run behind the iliac fascia.[8] Fascia iliaca compartment block (FICB), proposed by Dalens in 1989,[9] is effective in blocking the above nerves with few adverse effects. FICB is well-accepted as a perioperative analgesia for patients with hip fracture. Both British and American physician associations recommend FICB for early analgesia following hip fracture.[10]

Therefore, this study aimed to investigate the effects of intraoperative FICB on perioperative pain, limb function recovery, and incidence of complications among elderly patients with hip fracture. We hypothesized that FICB will enhance postoperative pain relief and functional recovery, compared to routine analgesia (RA).

Patients and Methods

Study Design

This was a prospective, observational, and randomized study that compared RA and FICB in the management of postoperative pain and hip joint function following hip fracture surgery. This trial is registered at www.chictr.org.cn with the registration number: ChiCTR2100049932. A total of 120 elderly patients, admitted to our institution, due to hip fracture, between January 2019 and December 2020, were included in our analysis. This study was approved by the ethics committee of our institution. We obtained written informed consent from all patients prior to the initiation of the study.

Inclusion and Exclusion Criteria

The inclusion criteria were as follows: (i) X-ray diagnosis of a unilateral hip fracture (intertrochanteric or femoral neck fracture); (ii) age ≥60 years; (iii) receiving surgery in our hospital, including hemiarthroplasty or total hip arthroplasty for femoral neck fracture, and proximal femoral nail antirotation (PFNA) for intertrochanteric fracture. Patients with contraindications for spinal anesthesia and regional blocks, previously diagnosed with chronic pain, previous surgery of affected limb, previous history of hip or femur fracture, renal failure, chronic use of opioids, allergy to drugs used in the study, and mental state preventing completion of scoring were excluded from the study. Since patients voluntarily participated, they could withdraw from our research at any time.

Treatment Groups and Protocols

Patients meeting the inclusion criteria (n=120) were randomly assigned to one of two groups (n=60 each), using a random sequence generator via sealed envelopes.

RA group—received only RA. Celecoxib 200 mg was provided orally immediately upon admission and 6 hours before surgery. Starting 6 hours post-surgery, the patient was switched to intramuscular parecoxib 40 mg for 3 days, then to oral celecoxib 200 mg after 3 days. All dosing frequencies were once every 12 hours. Morphine was offered if analgesia was inadequate.

FICB group—received both RA and FICB.

The statisticians, data collectors, and evaluators were blinded to the allocation results.

Interventions

The interventions used in the study were RA and FICB. Patients allocated to the FICB group were administered FICB after spinal anesthesia by a singular highly experienced anesthetist. Briefly, a typical patient was placed in the supine position. A line was drawn from the pubic tubercle to the anterior superior iliac spine, and divided into three sections. The puncture site was marked 1 cm caudal to the point dividing the lateral third and medial two-thirds of this line. After sterilizing the skin, a 45° short inclined puncture needle (Plexufix®25 mm, 24-G.B. Braun Melsungen AG) was inserted perpendicular to the skin until two "pops" became evident, indicating puncturing of the fascia lata and fascia iliaca. Upon confirmation of the needle perforation of the iliac fascia, followed by negative aspiration, a total of 30 mL of .33% ropivacaine hydrochloride, 1% lidocaine, and 5 mg dexamethasone were gradually injected deep to the iliac fascia.

Surgery and Rehabilitation

All femoral neck fracture surgeries were performed by the same team of arthrology doctors. The intertrochanteric

fracture surgery was similarly performed by the same team of trauma doctors. The internal fixation surgeries were performed on traction tables, with the patient lying supine, as opposed to hemiarthroplasty or total hip arthroplasty surgeries, which were performed with the patient lying lateral decubitus. During surgery, no additional local anesthetics or opioids were administered. After strict hemostasis was achieved, all procedures were completed within 90 minutes. The suction drain was not used after the operation. Lastly, X-ray images were captured again before initiating postoperative rehabilitation regimen the day after surgery, with the guidance of the rehabilitation department. All patients were given low molecular weight heparin (LMWH) for anticoagulation after surgery, and switched to rivaroxaban at discharge, with 35 days of total anticoagulation.

Outcome Measurements

The present study employed the visual analog scale (VAS) scores (0-10, with 0 indicating no pain and 10 indicating the worst pain possible) to evaluate the analgesic effect during and after surgery. The VAS scores were recorded at rest (lying flat) and with movement (movement-associated pain was elicited by passively elevating the fractured leg to 15°)[11] at 6 hours, 1 and 3 days, 1, 2, and 6 weeks, and 3 months post operation. The HHS, originally developed by Dr William Harris[12] in 1969, is one of the oldest and most commonly used measurement in orthopedic research. It has 4 subscales, namely, pain, function, absence of deformity, and range of motion, and it ranges from 0 (worst) to 100 (best). The HHS were evaluated at 1, 6 weeks, and 3 months post operation. Other analyzed outcomes included postoperative complications like cardiovascular and cerebrovascular events, pulmonary infection, urinary tract infection, and lower limb venous thrombosis; adverse events after analgesia like dizziness, nausea, vomiting, puncture site infection, and hematoma; as well as length of hospital stay.

Statistical Analysis

The sample size was estimated based on a preliminary test that compared the VAS scores between groups, using a one-way repeated measures analysis of variance (ANOVA). At least 54 patients in each group were required to complete the study and the assumptions of 5% type I error rate, 80% power, and .45 effect size were considered. Based on the assumption of a dropout rate of 10%, 60 patients were required to be enrolled in each group. Therefore, a total of 120 patients were included in the statistical analysis, 60 cases were included in the RA group and 60 cases in the FICB group.

To confirm comparability between cohorts, the intergroup VAS score and HHS differences were analyzed using independent two-sample t-tests. A one-way repeated measures analysis of variance (ANOVA) was performed to determine differences in pain intensity and function between groups at different times. Complications and adverse events were presented as frequency and percentage and compared using the Chi-square test. $P < .05$ was considered statistically significant. All analyses were carried out using the SPSS 22.0 (IBM, USA) statistical software.

Results

A total of 120 patients with hip fracture were included in this study. No patients were excluded after allocation. There were no significant differences in age, gender, height, weight, preoperative diagnosis, and surgical procedure between the two groups ($P > .05$). The general patient demographics and surgical characteristics are summarized in Table 1.

Pain and Function Improvement

The recorded pain severities at all follow-ups are presented in Tables 2 and 3. The VAS scores at rest were significantly lower in the FICB group, compared to the RA group at 6 hours, 1 and 3 days, 1 week post operation ($P < .001$) and no significant differences were observed at other time points. Based on the repeated measures ANOVA, both groups exhibited reduced pain scores at all follow-ups, and there were significant differences between the groups ($F_{group}=23.565$, $P_{group}<.001$). We also observed significant time ($F_{time}=260.607$, $P_{time}<.001$) and interaction effects between times and groups, respectively ($F=15.165$, $P < .001$). Fig.1 presents the pain alterations at rest.

The VAS scores with movement were significantly lower in the FICB group, compared to the control group at 6 hour, 1 and 3 days, as well as 1 and 2 weeks post operation ($P < .001$), and no significant differences were observed at other time points. At all follow-ups, the repeated measures ANOVA confirmed that the study group and time point significantly influenced pain control with movement ($F_{time}=215.97$, $P_{time} < .001$; $F_{group}=27.23$, $P_{group} < .001$). Furthermore, there was an interaction effect between time points and study groups ($F=15.165$, $P < .001$). The alterations in pain with movement are displayed in Fig. 2.

There were significant differences in HHS between the two groups at 7 days post operation (Table 4, $P < .001$), and no significant differences were observed at other time points. Using repeated measures ANOVA, we demonstrated that there were significant regulation between time points ($F_{time}=942.538$, $P_{time}<.001$), significant effect

Table 1. Patient demographics.

Characteristics	RA Group (n=60)	FICB Group (n=60)	χ2/t	P
Age, years	76.18±11.55	76.53±8.96	.19	.85
Gender (male/Female)	23/37	20/40	.33	.57
Height, cm	162.67±8.51	162.90±8.54	.15	.88
Weight, kg	61.13±12.89	63.44±13.01	.98	.33
Body mass index, kg/m2	23.02±4.08	23.73±3.42	1.04	.30
Preoperative diagnosis (N/I)	36/24	36/24	.00	1.00
Surgical procedure (B/T/I)	28/5/27	24/11/25	2.64	.27

Results are presented as mean ± standard deviation.
FICB, fascia iliaca compartment block; RA, routine analgesia; N, femoral neck fracture; I, intertrochanteric fracture; B, bipolar hemiarthroplasty; T, total hip arthroplasty; I, internal fixation.

Table 2. The postoperative VAS pain at rest.

	RA Group	FICB Group	t	P
1d pre	4.92±1.76	5.00±1.46	−.526	.599
6h	4.53±1.22	3.02±.90	−6.549	.000
1d	4.20±1.14	2.86±.82	−6.243	.000
3d	3.44±.84	2.73±.69	−4.568	.000
1w	2.58±.77	2.25±.78	−2.075	.038
2w	2.12±.81	1.88±.77	−1.553	.12
6w	1.78±.77	1.54±.68	−1.731	.083
3m	1.34±.82	1.27±.74	−.350	.726

Table 3. The postoperative VAS pain scores with movement.

	RA Group	FICB Group	t	P
6h	6.20±1.14	4.17±1.12	−7.436	.000
1d	5.53±.92	4.02±.99	−6.874	.000
3d	4.47±.82	3.54±.80	−5.702	.000
1w	3.64±.78	2.92±.90	−4.333	.000
2w	2.90±.61	2.44±.75	−3.327	.001
6w	2.42±.79	2.32±1.01	−.605	.545
3m	2.15±.85	2.12±.91	−.189	.850

between groups (F_{group}=12.233, P_{group}=.001), and significant interaction effect between time and group (F=30.395, $P < .001$). The changes in HHS are presented in Fig. 3.

Other Outcomes

Complication incidences in the FICB group were lower than the RA group, but the differences were not statistically significant (χ2=9.21, P=.42, Table 5). The postoperative adverse event incidences were similar between the two groups (χ2=2.42, P =.6). There was only one case of puncture site hematoma that was reported in the FICB group, which disappeared with local compression. Although the length of stay in the hospital was 2.12 days shorter in the FICB group than the RA group, there was no statistically significant difference between the two groups (χ2 = 34.27, P = .13).

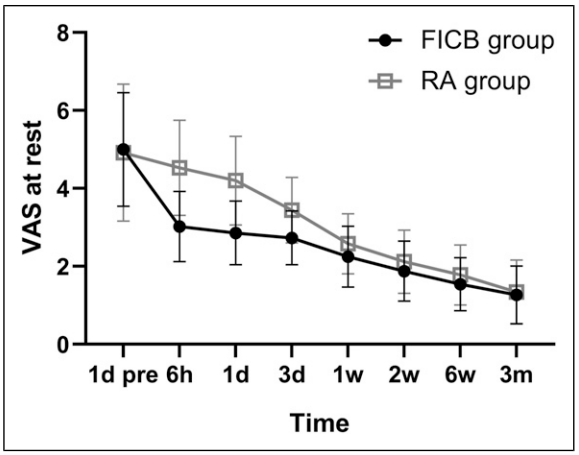

Figure 1. Alterations in resting pain VAS scores from baseline to 3-month follow-up assessment.

Patient Mortality

A total of two patients died postoperatively. One was in the RA group and suffered a sudden cardiac event, and the other was in the FICB group and experienced a cerebral infarction.

Discussion

Patients with hip fracture often suffer from severe pain, particularly during posture alterations that accompanies examination and treatment. Pain management is critical in the pre-and post-operative period of elderly hip fracture patients. Hence, good pain management can vastly improve patient outcomes. Traditional surgical anesthesia methods for hip fracture mostly involve epidural anesthesia. Although this meets the needs of surgical treatment,

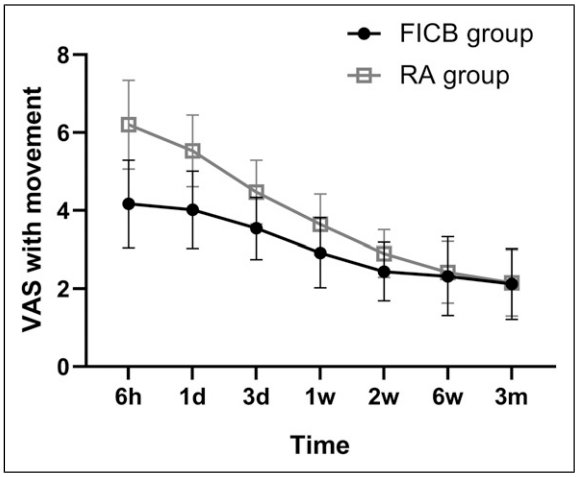

Figure 2. Alterations in VAS pain scores with movement at the 3-month follow-up assessment.

Table 4. Harris hip scores (HHS).

	RA Group	FICB Group	t	P
7d	40.02±9.61	53.41±8.63	−6.504	.000
6w	66.71±12.05	70.85±10.74	−1.860	.063
3m	82.49±13.03	83.24±10.31	−.086	.931

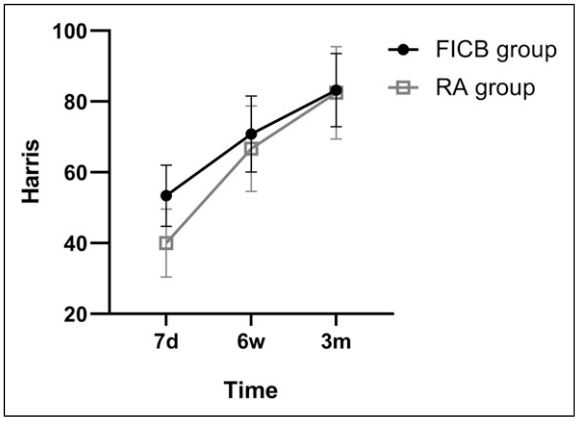

Figure 3. Alterations in Harris hip scores (HHS) at the 3-month follow-up assessment.

pain sensation tends to return early after surgery. Epidural analgesia after surgery provides good analgesia, but it has fallen out of favor as anticoagulants and early ambulation are often considered necessary. Early postoperative analgesia is important for the rapid recovery of hip function.[13] With the popularization and application of ultrasound visualization technology, precise nerve block has made great progress. In addition to FICB, there are other modalities for analgesia such as femoral nerve block, pericapsular nerve group block and lumbar plexus nerve block. The FICB technique is associated with minimal risk because the puncture is made at a safe distance from the femoral artery and femoral nerve. It was demonstrated that even a low dose can significantly relieve pain within a few hours.[14]

Our study revealed that the techniques of regional anesthesia can markedly decrease postoperative pain at rest and with movement. Previous studies suggested that intravenous opioids could relieve pain at rest, but pain relief during movement is limited.[11,15] In Norio Yamamoto's study comparing intravenous acetaminophen and FICB after hip fracture operation, patients who received FICB experienced significantly less pain with movement at seventh day after surgery.[16] However, they did not assess VAS scores after 1 week post-surgery. They only used .25% levobupivacaine, while we used a combination of ropivacaine hydrochloride, lidocaine, and dexamethasone. Dexamethasone prolongs the duration and intensity of the local anesthetic nerve block by producing vasoconstriction locally and thereby inhibiting absorption of the anesthetic agent from the site of injection.[17] Some studies have also concluded that systemic dexamethasone is as efficacious as perineural dexamethasone.[18] Moreover, ropivacaine hydrochloride is a long-acting anesthetic. Lidocaine is only used as a routine anesthetic when performing nerve blocks in our institution. The combination of different local anesthetics may also prolong the duration of effect. Further experiments are needed to confirm the interactions between different anesthetics. Ma et al[5] conducted a randomized controlled trial involving 88 elderly patients with hip fracture, in which the experimental group received continuous FICB. The authors revealed that the patients who received FICB experienced lower pain whether at rest or with movement. Moreover, FICB increased analgesia satisfaction, shortened length of hospital stay, and reduced hospitalization costs. Our conclusions supported these prior results, as we also observed that FICB provided better pain relief at rest within one week after surgery and during movement within two weeks after surgery. Therefore, FICB may help with early postoperative pain. However, no significant difference was observed in long-term results.

To our knowledge, few studies evaluated the impact of FICB on postoperative joint function. Our study demonstrated that the HHS are superior in the FICB group compared to the RA group, within the first week post operation. We believe this is due to the better pain management of FICB in the early postoperative period, which ultimately induced better joint function in the FICB group, compared to the RA group. Thompson et al[19] achieved similar results in their study. They compared the average walking distance of hip fracture patients after surgery. On the third day after surgery, the average walking distance of the FICB group increased by 50%, compared to the RA group. Moreover, patient

Table 5. Numbers of complications and adverse events in the RA and FICB groups.

		RA Group	FICB Group	χ2/t	P
Complications	Pulmonary infection	8	7		
	Urinary tract infection	5	4		
	Deep vein thrombosis	2	1		
	Cerebral infarction	1	0		
	Myocardial infarction	0	1		
	Total	16 (26.67%)	13 (21.67%)	9.21	.42
Adverse events	Dizziness	9	7		
	Nausea and vomiting	10	7		
	Puncture site hematoma	/	1		
	Total	19 (31.67%)	15 (25.00%)	2.42	.66
Hospital stay		17.98±6.30	15.86±5.43	34.27	.13
Mortality		1	1		

satisfaction increased significantly by 31%. FICB promotes the recovery of hip joint function in the early postoperative period, and at the same time, obtains more satisfactory clinical outcomes. However, there was no significant difference in long-term HHS.

Opioids are mainly used for traditional perioperative analgesia. Despite definite analgesic effects, opioids induce relatively clear adverse events (such as, dizziness, nausea, vomiting, urinary retention, skin itching, respiratory depression, and so on), which negatively affect postoperative recovery.[19] Therefore, it is crucial to take measures to reduce opioid usage during the perioperative period. Previous studies revealed that FICB provides effective perioperative analgesia for elderly patients with hip fractures, with an effective rate of 90%.[20] At the same time, it reduces the stress response of perioperative patients. Delirium is one of the most common complications in these patients, with incidence ranging from 38% to 62%, and it increases with age, comorbidities, and cognitive status.[21,22] The current study suggests that severe postoperative pain is a critical predisposing factor for delirium, and severe pain accelerates the activation and release of pro-inflammatory cytokines,[23] which consequently promote development of delirium.[24,25] The pre-emptive analgesic effect of FICB can reduce the release of pro-inflammatory cytokines, thereby preventing the occurrence of perioperative delirium. In addition, reducing opioid usage can also reduce release of pro-inflammatory cytokines.[26]

If a relatively significant analgesic effect can be confirmed, FICB may be used more in the future. A retrospective study by Wennberg[15] compared the analgesic effects of intravenous opioids and FICB on patients with suspected hip fracture during the pre-hospital emergency care. The results of the study revealed that FICB has a more significant effect in relieving pain, and reduces occurrence of adverse events. FICB can therefore be used as a safe and effective approach to treating pre-hospital pain in patients with hip fracture.[27] In addition, continuous fascia iliaca compartment block provides an effective treatment for patients with long-term chronic pain post operation.[28]

However, some researchers hold different views about FICB. Alan et al used peripheral nerve blocks targeting the fascia iliaca compartment to improve postoperative pain after hip arthroscopy surgery. The randomized controlled trial revealed that, in terms of postoperative pain control, injection of local anesthetics into the fascia iliaca compartment does not improve pain, compared to sham injection. They also found that FICB contributed to a decrease in quadriceps strength and increase the risk of falling after surgery.[29] In our study, we generally encourage patients to exercise in bed the first 3 days after operation and exercise out of bed with the assistance of rehabilitation doctors 3 days later. Unfortunately, we neglected to evaluate the quadriceps strength specifically, but no falls were observed in the early postoperative period owing to the rigorous rehabilitation exercise.

The use of FICB before hip arthroscopy remains to be discussed, and the results of the above clinical trials need to be validated with extensive clinical studies. In addition, the FICB targets are mainly the cutaneous lateral femoral nerve, femoral nerve, and obturator nerve, and FICB blocks pain input from these tissues. Nevertheless, FICB does not block the sciatic nerve, which innervates the back portion of the thigh. Traction during surgery or hematoma formed at the surgical site may produce nociceptive irritation to the posterior periosteal receptors of the femur, facilitating nociception transducted by the sciatic nerve. Therefore, additional analgesia may be required post-surgery to resolve the pain in the back of the thigh.[30]

There were several limitations to our study. First, we did not record the consumption of additional analgesics after surgery. Some researches revealed that FICB effectively reduces the consumption of opioids after hip surgery. In fact, Thompson compared the consumption of FICB and empiric analgesia in patients with hip fractures. The author

revealed that acetaminophen consumption in the mild pain group showed no statistical difference, tramadol consumption in the moderate pain group was reduced by 43%, and opioid consumption in the severe pain group was reduced by 98%.[19] Second, in view of the limited number of patients, it would be necessary to confirm if FICB reduces incidence of postoperative cardiovascular, pulmonary, and cerebral complications in elderly patients with hip fracture, using both multicenter and large-scale studies. Third, we used traditional landmark-based FICB without ultrasound. There was no testing to confirm the correct space of the block. It is necessary to make improvements in these aspects in subsequent experiments. Unfortunately, our patients were not blinded to the allocation as it would be unethical to implant a placebo fascia iliaca compartmental catheter purely for blinding purposes.

Conclusion

In conclusion, the present study demonstrated that fascia iliaca compartment block provides superior postoperative short-term analgesic effect both at rest and with movement, as well as accelerate postoperative short-term hip joint function recovery. However, there was no clear evidence that preoperative nerve block analgesia improves the long-term prognosis of elderly patients with hip fracture. This trial provides evidence for the analgesic usage of FICB before hip fracture surgery.

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Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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References

1. Peng K, Yao P, Yang L, et al. Parenthood and risk of hip fracture: a 10-year follow-up prospective study of middle-aged women and men in China. *Osteoporos Int*. 2020;31(4):783-791.
2. Barahona M, Barrientos C, Cavada G, Brañes J, Martinez Á, Catalan J. Survival analysis after hip fracture: higher mortality than the general population and delayed surgery increases the risk at any time. *HIP Int*. 2020;30(1_suppl l):54-58.
3. Colais P, Di Martino M, Fusco D, Perucci CA, Davoli M. The effect of early surgery after hip fracture on 1-year mortality. *BMC Geriatrics*. 2015;15:141.
4. Moja L, Piatti A, Pecoraro V, et al. Timing matters in hip fracture surgery: patients operated within 48 hours have better outcomes. A meta-analysis and meta-regression of over 190,000 patients. *PLoS One*. 2012;7(10):e46175.
5. Ma Y, Wu J, Xue J, Lan F, Wang T. Ultrasound-guided continuous fascia iliaca compartment block for pre-operative pain control in very elderly patients with hip fracture: A randomized controlled trial. *Exp Ther Med*. 2018;16(3):1944-1952.
6. Tran T, Delluc A, de Wit C, Petrcich W, Le Gal G, Carrier M. The impact of oral anticoagulation on time to surgery in patients hospitalized with hip fracture. *Thromb Res*. 2015;136(5):962-965.
7. Colman M, Choi L, Chen A, Crossett L, Tarkin I, McGough R. Proximal femoral replacement in the management of acute periprosthetic fractures of the hip: a competing risks survival analysis. *J Arthroplasty*. 2014;29(2):422-427.
8. Monzon DG, Iserson KV, Vazquez JA. Single fascia iliaca compartment block for post-hip fracture pain relief. *J Emerg Med*. 2007;32(3):257-262.
9. Parkinson SK, Mueller JB, Little WL, Bailey SL. Extent of blockade with various approaches to the lumbar plexus. *Anesth Analg*. 1989;68(3):243-248.
10. Miller GW, Godrey JJ, Sagmeister ML, Lewis TL. Provision of fascia iliaca compartment block in the acute management of proximal femoral fractures: A national observational study of UK hospitals. *Injury*. 2016;47(11):2490-2494.
11. Foss NB, Kristensen BB, Bundgaard M, et al. Fascia iliaca compartment blockade for acute pain control in hip fracture patients. *Anesthesiology*. 2007;106(4):773-778.
12. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures. *J Bone Joint Surg*. 1969;51(4):737-755.
13. Gaffney CJ, Pelt CE, Gililland JM, Peters CL. Perioperative pain management in hip and knee arthroplasty. *Orthop Clin N Am*. 2017;48(4):407-419.
14. Wennberg P, Möller M, Herlitz J, Kenne Sarenmalm E. Fascia iliaca compartment block as a preoperative analgesic in elderly patients with hip fractures - effects on cognition. *BMC Geriatrics*. 2019;19(1):252.
15. Wennberg P, Hillberg Hörnfeldt T, Stål S, Herlitz J, Björås J, Larsson G. Fascia iliaca compartment block (FICB) as pain treatment in older persons with suspected hip fractures in prehospital emergency care - A comparative pilot study. *International emergency nursing*. 2021;57:101012.
16. Yamamoto N, Sakura S, Noda T, et al. Comparison of the postoperative analgesic efficacies of intravenous acetaminophen

and fascia iliaca compartment block in hip fracture surgery: A randomised controlled trial. *Injury.* 2019;50(10):1689-1693.
17. Sherif AA, Elsersy HE. Dexamethasone as adjuvant for femoral nerve block following knee arthroplasty: a randomized, controlled study. *Acta Anaesthesiologica Scandinavica*. 2016;60(7):977-987.
18. Baeriswyl M, Kirkham KR, Jacot-Guillarmod A, Albrecht E. Efficacy of perineural vs systemic dexamethasone to prolong analgesia after peripheral nerve block: a systematic review and meta-analysis. *Br J Anaesth*. 2017;119(2):183-191.
19. Thompson J, Long M, Rogers E, et al. Fascia iliaca block decreases hip fracture postoperative opioid consumption: a prospective randomized controlled trial. *J Orthop Trauma*. 2020;34(1):49-54.
20. Elkhodair S, Mortazavi J, Chester A, Pereira M. Single fascia iliaca compartment block for pain relief in patients with fractured neck of femur in the emergency department. *Eur J Emerg Med*. 2011;18(6):340-343.
21. Bitsch MS, Foss NB, Kristensen BB, Kehlet H. Acute cognitive dysfunction after hip fracture: frequency and risk factors in an optimized, multimodal, rehabilitation program. *Acta Anaesthesiologica Scandinavica*. 2006;50(4):428-436.
22. Witlox J, Eurelings LSM, de Jonghe JFM, Kalisvaart KJ, Eikelenboom P, van Gool WA. Delirium in elderly patients and the risk of postdischarge mortality, institutionalization, and dementia. *JAMA*. 2010;304(4):443-451.
23. Cidral-Filho FJ, Martins DF, Moré AOO, et al. Light-emitting diode therapy induces analgesia and decreases spinal cord and sciatic nerve tumour necrosis factor-α levels after sciatic nerve crush in mice. *Eur J Pain*. 2013;17(8):1193-1204.
24. Plaschke K, Fichtenkamm P, Schramm C, et al. Early postoperative delirium after open-heart cardiac surgery is associated with decreased bispectral EEG and increased cortisol and interleukin-6. *Intensive Care Medicine*. 2010; 36(12):2081-2089.
25. van Munster BC, Aronica E, Zwinderman AH, Eikelenboom P, Cunningham C, de Rooij SEJA. Neuroinflammation in delirium: a postmortem case-control study. *Rejuvenation Research*. 2011;14(6):615-622.
26. Winterhalter M, Brandl K, Rahe-Meyer N, et al. Endocrine stress response and inflammatory activation during CABG surgery. A randomized trial comparing remifentanil infusion to intermittent fentanyl. *Eur J Anaesthesiol*. 2008;25(4): 326-335.
27. Davis S, Olaussen A, Bowles KA, Shannon B. Review article: Paramedic pain management of femur fractures in the prehospital setting: A systematic review. *Emerg Med Australasia (EMA): Emerg Med Australasia (EMA)*. 2021; 33(4):601-609.
28. Rasappan K, Chua ITH, Tey JBL, Ho SWL. The continuous infusion fascia iliaca compartment block: a safe and effective analgesic modality in geriatric hip fracture patients. *Arch Orthop Trauma Surg*. 2021;141(1):29-37.
29. Zhang AL. Editorial Commentary: The Truth about Peripheral Nerve Blocks and Hip Arthroscopy. *Arthrosc J Arthrosc Relat Surg*. 2019;35(9):2617-2618.
30. Nie H, Yang Y-X, Wang Y, Liu Y, Zhao B, Luan B. Effects of continuous fascia iliaca compartment blocks for postoperative analgesia in patients with hip fracture. *Pain Res Manag*. 2015;20(4):210-212.