ORIGINAL ARTICLE

Application of hip capsule peripheral nerve block in early analgesia in elderly patients with hip fracture

Aplicación del bloqueo del nervio periférico de la cápsula de la cadera en analgesia temprana en pacientes ancianos con fractura de cadera

*Jiangbo Zheng, Zhaoming Feng, Junfeng Zhu, and Yuqing Kang**

Department of Anesthesiology, Jinshan Branch of Shanghai Sixth People's Hospital, Shanghai, China

Abstract

Objective: *The objective of the study is to investigate the effect of pericapsular nerve group (PENG) block in early analgesia in elderly patients with hip fracture.* **Methods:** *A total of 44 elderly patients with hip fracture admitted to our hospital from August 2021 to December 2022 were selected and divided into 2 groups according to different analgesia programs.* **Results:** *At T_1~T_4, the resting and active visual analog scale (VAS) scores in group P were lower than group F ($p < 0.05$). The resting and active VAS scores at T_5 in both groups were no visible differences ($p > 0.05$). After 30 min of block, systolic blood pressure, diastolic blood pressure, and heart rate were decreased in both groups ($p < 0.05$), but no obvious difference was found in the two groups ($p > 0.05$). Before surgery, Pittsburgh Sleep Quality Index (PSQI) and mini–mental state scale (MMSE) scores in both groups were reduced, and PSQI score in group P was lower than that in group F and MMSE score was higher than group F ($p < 0.05$).* **Conclusions:** *PENG technology is safe and effective in the early analgesia of elderly hip fractures. It can effectively block physiological stress response caused by acute trauma, improve pre-operative sleep quality, and reduce the incidence of cognitive dysfunction.*

Keywords: *Hip fracture. Pericapsular nerve group block. Fascia iliaca compartment block. Early analgesia. Security.*

Resumen

Objetivo: *Investigar el efecto del bloqueo del grupo del nervio pericapsular en analgesia temprana en pacientes ancianos con fractura de cadera.* **Métodos:** *Se seleccionaron 44 pacientes ancianos con fractura de cadera ingresados en nuestro hospital entre agosto de 2021 y diciembre de 2022, divididos en dos grupos según diferentes programas de analgesia.* **Resultados:** *En T1~T4, los valores de la escala visual análoga (EVA) en reposo y con actividad en el grupo P fueron menores que en el grupo F ($p < 0.05$). Los puntajes de la EVA en reposo y en actividad en T5 en ambos grupos no mostraron diferencias visibles ($p > 0.05$). Después de 30 minutos de bloqueo, la presión arterial sistólica y diastólica, y la frecuencia cardiaca, disminuyeron en ambos grupos ($p < 0.05$), pero no se encontró una diferencia obvia entre ellos ($p > 0.05$). Antes de la cirugía, las puntuaciones del Pittsburgh Sleep Quality Index (PSQI) y de la Mini-Mental State Scale (MMSE) en ambos grupos eran reducidas, y la puntuación del PSQI en el grupo P fue menor que en el grupo F, y la puntuación del MMSE fue mayor que en el grupo F ($p < 0.05$).* **Conclusiones:** *La técnica de bloqueo del grupo del nervio pericapsular es segura y efectiva en la analgesia temprana de fracturas de cadera en ancianos. Puede bloquear eficazmente la respuesta al estrés fisiológico causado por un trauma agudo, mejorar la calidad del sueño preoperatorio y reducir la incidencia de disfunción cognitiva.*

Palabras clave: *Fractura de cadera. Bloqueo del grupo del nervio pericapsular. Bloqueo de la fascia iliaca. Analgesia temprana. Seguridad.*

***Correspondence:**
Yuqing Kang
E-mail: k_yuqing@126.com

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Introduction

With the rapid development of our economy and society, the problem of aging population and prevention of related diseases have become a hot topic. As one of the emergencies in elderly population, hip fracture can lead to severe pain, especially during the early position change and moving examination, which can cause the excitation of the sympathetic adrenal medulla axis, leading to a series of stress reactions[1,2]. For elderly patients, trauma and pain stimulation have more severe effects on the whole body. Pain may affect the secretion of hormones by changing the patients' sleep rhythm, thus leading to the occurrence of delirium[3]. Post-operative delirium and cognitive dysfunction are highly common in elderly orthopedic patients. Studies have shown that the incidence of post-operative delirium in elderly orthopedic surgery patients ranges from 25% to 48%, which may even cause permanent cognitive dysfunction and seriously affect brain function and prognosis[4,5]. At present, studies on pain control in elderly patients with hip fracture tend to focus on post-operative pain management and pay insufficient attention to the period from the occurrence of trauma to the start of surgery. Previous clinical studies have shown that non-steroidal anti-inflammatory drugs (NSAIDs) given in acute pain can significantly improve the prognosis of patients, but such drugs may increase the risk of cardiovascular adverse events, coagulation disorders, and peptic ulcers[6]. Opioids are another method for pre-operative pain management, but they can be accompanied by side effects such as nausea, vomiting, dizziness and respiratory depression, and their application is limited, especially for elderly patients with many complications[7]. Moreover, improper use of opioids can increase the occurrence of adverse events such as delirium and may even lead to death[8]. The sensory fibers of the hip joint are mainly distributed in the front of the hip capsule, and the innervation mainly comes from the branches of the lumbar plexus. Studies have reported that fascia iliaca compartment block (FICB) is better than fentanyl and non-steroidal analgesics in the early analgesia of patients with hip fractures, but it has some defects such as large local anesthetic volume and total dose and excessive poisoning risk for elderly patients[9,10]. Therefore, finding safe and effective early analgesic methods for elderly patients with hip fracture are still an urgent clinical problem.

Pericapsular nerve group block (PENG) as a new block technique, which uses ultrasound-guided puncture technology and in-plane injection method to attach the nerve block needle to the anterior inferior iliac spine, accurately inject local anesthetics into the acetabular bone surface, block the femoral nerve and obturator nerve distributed in front of the hip capsule at the same time, and can quickly and effectively relieve the pain after hip fracture[11,12]. In addition, the PENG has a wide range of clinical application prospects for the simple implementation, short operation time, rapid onset, and low incidence of adverse reactions. However, there are few reports of early analgesia with PENG in elderly patients with hip fracture. Therefore, this study compared the early analgesia efficacy of PENG and FICB in elderly patients with hip fracture.

Materials and methods

Ethical approval of the research protocol

This study was approved by the hospital Ethics Committee. All patients signed an informed consent form agreeing to participate in the clinical study.

Patients

The elderly with hip fracture treated in our hospital were included in the study. Inclusion criteria: age 65 years old or above, expected to undergo surgery within 72 h, visual analog scale (VAS) score > 4, no serious heart, liver, kidney diseases. Exclusion criteria: history of scar, infection and local anesthetics at the puncture site, refusing a nerve block, inability to coordinate and communicate well with doctors. A total of 44 patients were divided into PENG group (group P) and FICB group (group F) according to the different analgesia programs. There were 24 cases in Group P and 20 cases in Group F. Moreover, anesthesia was performed by the same neurosurgeon with over 15 years of resident experience.

Analgesia method

Group P received ultrasound-guided PNGB analgesia regimen: the patients were placed in supine position, routinely disinfected and covered, and the portable two-dimensional ultrasound instrument (Sonosite, USA) was used for detection. The linear array

probe of 10~13 MHz was placed on the joint line between the anterior superior iliac spine and the pubic bone, and then, the probe was shifted toward the tail end and slightly toward the head end when the image of the femoral head appeared under ultrasound. At this time, the image of the femoral head disappeared. The presence of a high-echo bright line is the iliopubic process, the medial side is the ramus of the pubis, the lateral side is the anterior inferior iliac spine, the superficial side of the bone surface is the iliopsoas muscle, and the medial side is the femoral artery. The in-plane injection method was adopted, and 22G local anesthesia needle was used to puncture the anterior inferior iliac spine to the acetabular bone surface from the outside to the inside. When no blood was drawn back, the 15 mL 0.25% ropivacaine was injected. The ultrasonography images in figure 1 show the anatomical structure of puncture site.

Group F received ultrasound-guided FICB analgesia regimen: the patients were placed in supine position, routinely disinfected and covered, and a portable two-dimensional ultrasound instrument (Sonosite, USA) was used. The puncture point was set at the junction of the middle 1/3 of the line between the anterior superior iliac spine and the pubic tuberous node, opening 1.5 cm to the caudal side. The linear array probe of 10~13 MHz was placed parallel to the inguinal fold. The fascia lata, iliac fascia, and iliopsoas muscle on the ultrasound image were confirmed. The injection was performed from the outside to the inside by in-plane technique. After experiencing two breakthrough sensations, no blood was extracted and 15 mL 0.25% ropivacaine was injected. Then, the probe was placed parallel to the inner thigh along the extended line of the inguinal fold, and the space between the adductor longus, adductor brevity, and adductor magnus was identified by ultrasonic development. Subfascia obturator nerve block was used, and 5 mL 0.25% ropivacaine hydrochloride was injected. The ultrasonography images in figure 2 show the anatomical structure of puncture site.

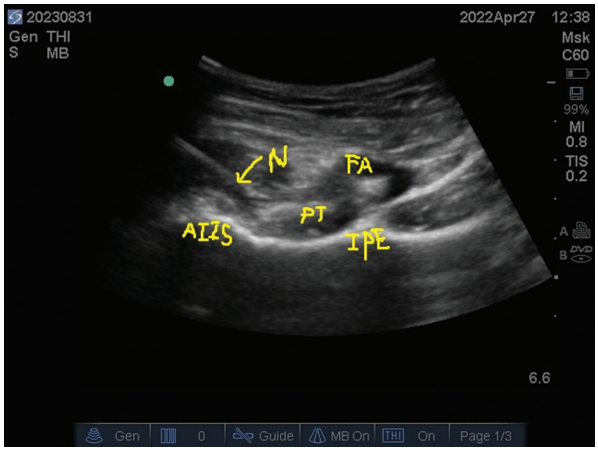

Figure 1. *PENG block. AIIS: anterior inferior iliac spine; FA: femoral artery; IPE: iliopubic eminence; PT: psoas tendon; N: needle.*

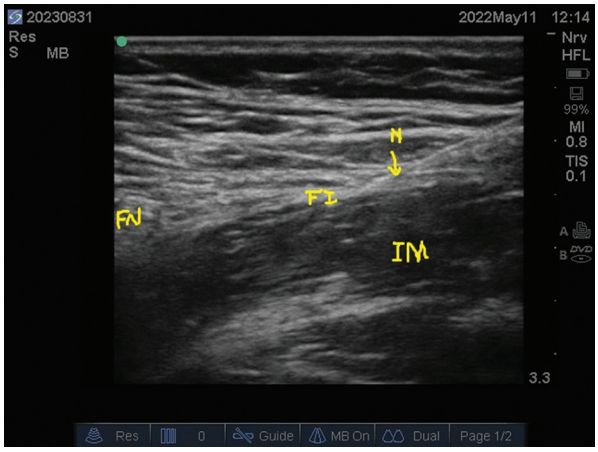

Figure 2. *Fascia iliaca block. FI: fascia iliaca; FN: femoral nerve; IM: iliacus muscle; N: needle.*

Outcome measures

The scores of resting and active VAS were evaluated before block (T_0), block for 5 min (T_1), 10 min (T_2), 20 min (T_3), 30 min (T_4), and the next morning after hospitalization (T_5). The vital signs of the two groups were evaluated, including systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) changes before and 30 min after the block. The sleep quality and cognitive function status of the two groups were evaluated at admission and before the surgery. The time from admission to operation and the situation of analgesic drugs within 24 h after operation were recorded in both groups, and the safety of the two groups was assessed.

Statistical analyses

SPSS 22.0 statistical software was used to analyze research data. Normally distributed continuous variables including VAS score, SBP, DBP, HR, PSQI, and MMSE scores were presented as the mean ± standard deviation, and comparison between groups was performed by independent sample t-test. Categorical

Table 1. Clinical characteristics of patients in the two groups

Variable	Group P (n = 24)	Group F (n = 20)	χ^2/t-values	p-values
Sex (male/female)	11/13	10/10	0.076	0.783
Age (years)	78.33 ± 7.75	79.25 ± 8.43	0.377	0.708
BMI (kg/m^2)	20.67 ± 2.85	21.20 ± 3.59	0.546	0.588
ASA grading (II/III)	13/11	11/9	0.003	0.956

BMI: body mass index; ASA: American Society of Anesthesiologists.

Table 2. Comparison of analgesic indexes between two groups

States	Groups	T_0	T_1	T_2	T_3	T_4	T_5
Resting state	Group P (n = 24)	4.88 ± 0.99	4.13 ± 1.19*	2.67 ± 1.13*	1.83 ± 0.92*	1.46 ± 0.51*	1.54 ± 0.88*
	Group F (n = 20)	5.00 ± 1.08	5.00 ± 1.08	4.15 ± 0.99*	3.35 ± 1.31*	1.95 ± 0.94*	1.70 ± 0.80*
	t-values	0.384	2.517	4.573	4.509	2.198	0.626
	p-values	0.703	0.016	0.000	0.000	0.034	0.535
Active state	Group P (n = 24)	6.69 ± 1.42	5.88 ± 0.90*	4.08 ± 1.41*	2.21 ± 1.18*	1.88 ± 0.90*	2.75 ± 0.90*
	Group F (n = 20)	6.76 ± 1.08	6.65 ± 1.39	5.65 ± 1.57*	3.50 ± 1.43*	2.40 ± 0.75*	2.80 ± 0.77*
	t-values	0.181	2.216	3.493	3.280	2.056	0.196
	p-values	0.857	0.032	0.001	0.002	0.046	0.846

*$p < 0.05$ versus T_0.

data were expressed as frequencies and percentages and analyzed using Chi-squared tests if appropriate. $p < 0.05$ was considered significant.

Results

Baseline characteristics

The gender, age, BMI, and ASA grading in two groups were no obvious differences ($p > 0.05$), as shown in table 1.

Analgesic indexes

At T_0, T_5, the VAS scores at resting and active state were all no visible differences among both groups ($p > 0.05$). At T_1~T_4, the VAS scores at resting and active state in group P were obviously decreased than those in group F ($p < 0.05$); the VAS scores at resting and active state in group P started decreasing from T_1, while those in group F were decreased from T_2, seen from table 2.

Stress response indexes

After blocking for 30 min, SBP, DBP, and HR were decreased in both groups ($p < 0.05$), but there was no obvious difference between two groups ($p > 0.05$), seen from table 3.

Sleep quality and cognitive function

At admission, PSQI and MMSE scores in two groups were no evident difference ($p > 0.05$). Before surgery, PSQI and MMSE scores were decreased in both groups, and PSQI score in group P was lower than that in group F and MMSE score in group P was higher than that in group F ($p < 0.05$), seen from table 4.

Time from admission to operation

The time from admission to operation in group P was (35.22 ± 6.78) hours, which was shorter than (48.45 ± 8.29) hours in group F (t = 5.825, $p < 0.05$).

Table 3. Comparison of SBP, DBP, and HR between the two groups before and 30 min after the block

Groups	SBP (mmHg)		DBP (mmHg)		HR (time/min)	
	Before block	30 min after the block	Before block	Block for 30 min	Before block	Block for 30 min
Group P (n = 24)	161.63 ± 24.17	139.46 ± 14.27*	91.67 ± 14.47	80.58 ± 11.58*	88.96 ± 16.69	75.79 ± 11.40*
Group F (n = 20)	152.90 ± 23.04	138.40 ± 16.92*	91.20 ± 10.85	79.50 ± 10.51*	86.80 ± 15.85	78.40 ± 11.60*
t-values	1.218	0.223	0.120	0.321	0.437	0.750
p-values	0.230	0.823	0.905	0.750	0.664	0.457

*$p < 0.05$ versus before block.
SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate

Table 4. Comparison of sleep quality and cognitive function between the two groups at admission and before operation

Groups	PSQI		MMSE	
	At admission	Before the surgery	At admission	Before the surgery
Group P (n = 24)	5.33 ± 1.38	4.09 ± 1.08*	26.19 ± 3.06	24.22 ± 3.15*
Group F (n = 20)	5.46 ± 1.44	4.85 ± 1.11*	26.49 ± 2.35	22.16 ± 3.22*
t-values	0.305	2.295	0.359	2.138
p-values	0.762	0.027	0.722	0.038

*$p < 0.05$ versus admission; PSQI: Pittsburgh Sleep Quality Index; MMSE: mini–mental state scale.

The situation of analgesic drugs within 24 h after surgery and adverse reactions

Group P was not treated with analgesic drug supplement after operation, and no adverse reactions occurred, while 3 cases in group F were given analgesic drug supplementation and 4 cases occurred nausea, vomiting, vertigo, and other adverse reactions (χ^2 = 3.863, 5.280, $p < 0.05$).

Discussion

The preferred treatment method for the elderly with hip fracture is surgery. Most elderly patients are physically weak, and the pain and stimulation caused by fracture will cause the body stress response, seriously affect the sleep quality of elderly patients, and further aggravate the weakness, which is not conducive to the control of patients' underlying diseases and may lead to the delay of surgical treatment[13]. With the popularization of the concept of accelerated rehabilitation, pre-operative analgesia has been paid more and more attention in clinic. In the past, drug analgesia was mainly used in clinical practice, but there were shortcomings such as incomplete analgesia and many adverse reactions[14]. At present, with the wide clinical application of ultrasound technology, perioperative analgesia, which is mainly based on nerve block and analgesia technology in affected area, has become a hot spot in clinical research[15].

Iliac fascia space nerve block is a commonly used nerve block technique in clinical practice. Theoretically, it can block femoral nerve and obturator nerve at the same time, and its effect in pre-operative analgesia is better than traditional drug analgesia. However, this technique has defects such as large dose, high risk of poisoning, and slow onset in elderly patients[16]. PENG block is a new type of block proposed based on hip innervation, which belongs to myofascial plane block. It is easy to master under the guidance of ultrasound, has a high success rate, and is suitable for continuous block and analgesia with catheterization[17]. Hence, this study investigated the effects of PENG block on analgesia, stress response, sleep quality, and cognitive function in elderly patients with hip fracture during pre-operative hospitalization and evaluated the safety of PENG block for elderly patients with hip fracture.

In this study, we compared the early analgesic efficacy of two block techniques in elderly patients with hip

fractures. The results showed that the VAS scores at resting and active state in group P at T_1~T_4 were obviously decreased than those in group F, and the VAS scores at resting and active state in group P started decreasing from T_1, while those in group F were decreased from T_2, suggesting PENG block technique is more effective and faster than FICB technique in early analgesia for elderly patients with hip fracture. The reason may be that the anterior capsule of the hip joint is innervated by obturator nerve, the accessory obturator nerve, and the femoral nerve, and it is the most abundant part of the hip joint nerve innervation. The hip joint branch of the femoral nerve and the accessory obturator nerve is always located between the anterior inferior iliac spine and the iliopubic uplift. Therefore, local anesthetic injection into the plane between them for nerve block is more targeted for hip fracture analgesia[18]. The results showed when blocking for 30 min, the SBP, DBP, and HR decreased in both groups, but there was no prominent difference between two groups, indicating the both blocks could effectively reduce the physiological stress response of elderly patients with hip fracture. Previous studies have shown that pain affects not only sleep but also cognitive function[19]. In the study, after blocking, PSQI and MMSE scores decreased in both groups, and PSQI score in group P was lower than that in group F, MMSE score in group P was higher than group F, revealing that the both blocks could improve the sleep quality of the elderly and play a certain protective effect on their neurological function, but the effect of PENG block was more significant. The possible mechanisms of the protective effect of nerve block on cognitive function are as follows: regional block can significantly reduce the dosage of general anesthesia drugs, reduce the concentration of inhaled anesthesia drugs, and thus, reduce the neurotoxic effects of general anesthesia drugs; regional block can reduce the stress of surgical trauma and pain on the whole body, inhibit the inflammatory response of the central nervous system, reduce the damage of the central nervous system, and thus protect the cognitive function[20].

In addition, the time from admission to operation in group P was shorter than that in group F, indicating the PENG block can shorten the pre-operative waiting time of patients. Moreover, Group P was not treated with analgesic drug supplement after operation, and no adverse reactions occurred, while 3 cases in group F were given analgesic drug supplementation and 4 cases occurred nausea, vomiting, vertigo, and other adverse reactions, further demonstrating the safety of PENG block in early analgesia in elderly patients with hip fracture.

Conclusions

The early analgesic effect of PENG block on elderly patients with hip fracture is significant, and the analgesic effect is fast. It can shorten the pre-operative waiting time of patients, create a good opportunity for surgery, reduce pain stimulation, improve the sleep quality of patients, further protect the cognitive function, and contribute to the rapid recovery of elderly patients with hip fracture. However, this study still shows some shortcomings. For example, this study has a limited sample size and a single source of cases, so the conclusions still need to be confirmed by a large number of large sample and multi-center studies.

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Conflicts of interest

All authors declare no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

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