Original Article

Comparison of the efficacy of pericapsular nerve group block (PENG) block versus suprainguinal fascia iliaca block (SFIB) in total hip arthroplasty: A randomized control trial

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ABSTRACT

Background and Aims: Hip replacement surgery is a commonly performed surgery with the aim of improving mobility in patients suffering from hip conditions. Though the modified suprainguinal approach of fascia iliaca block (SFIB) is commonly used, the analgesic efficacy is moderate and is associated with quadriceps weakness. The pericapsular nerve group (PENG) block has been used to block the sensory articular branches of the hip joint in various hip surgeries. This study aimed to compare SFIB with PENG block in terms of pain relief, opioid consumption and their adverse effects in patients undergoing primary total hip arthroplasties. (THA). **Methods:** Seventy ASA I/II patients undergoing primary THA were enrolled in this double-blinded, randomized trial. Patients were randomly allocated to one of the two groups: Group P: ultrasound (US)-guided PENG block and Group S: patients received the US-guided SFIB. **Results:** Postoperatively, there was statistically significant difference in numerical rating scale (NRS) scores at all-time intervals. Total morphine consumption in 24 hours and 48 hours was statistically more in SFIB group. Five patients had quadriceps weakness in the SFIB group. There was no difference in any other adverse effects. **Conclusion:** US-guided PENG block significantly reduces perioperative morphine consumption and pain scores in THA patients when compared to SFI block. It is not associated with quadriceps weakness as seen in SFIB.

Key words: Hip replacement, patient-controlled analgesia, peripheral nerve block

INTRODUCTION

Effective perioperative analgesia that minimizes the need for opioids and its related adverse effects (nausea, vomiting, respiratory depression) is essential to facilitate early patient rehabilitation after total hip arthroplasty (THA).[1,2] Commonly used peripheral nerve blocks include femoral nerve (FN) block, fascia iliaca block (FIB) and 3-in-1 FN block.[3] The suprainguinal approach of FIB (SFIB) is a relatively new block with moderate analgesic efficacy as it spares the obturator nerve (ON). It is also associated with motor weakness.[4-7] The high articular branches from FN and accessory obturator nerve (AON) are consistently found between the anterior inferior iliac spines (AIIS) and the iliopubic eminence(IPE), whereas the ON is close to the inferomedial acetabulum. Based on this information, an USG technique for the blockade of articular branches to the hip and the PENG block was described.[8] Studies have shown that PENG provides effective analgesia of the hip with the blockade of the three nerves.[8]

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Our hypothesis was that PENG block would provide better analgesia than SFIB as it would consistently block the hip nerve supply. It would also be associated with lesser quadriceps weakness in these patients as it spares the posterior mechanoreceptors. Hence, we aimed to compare the analgesic efficacy of SFIB with PENG block in patients undergoing primary THA. The primary outcome was to compare postoperative morphine requirements (24 hours). The secondary outcomes were to compare NRS scores (0, 1, 3, 6, 12 and 24 hours), adverse effects like vomiting, respiratory depression and quadriceps weakness at 6 hours. There have been studies published in literature comparing both the blocks, there have been no published literature on Indian population, and the results of previous studies are conflicting.[9]

METHODS

This double-blinded, randomized trial was done in tertiary care centre from 1 April 2021 to 31 March 2022, after approval from the ethics committee was obtained dated 09/06/2020 and CTRI approval (CTRI/2021/03/032041). Sixty patients, American Society of Anaesthesiologists (ASA) physical status I/II patients, between the age group 25 and 75 years, scheduled to undergo unilateral primary THA under general anaesthesia were included in this study. Patients who refused to give consent for the study, those with focal neurological deficit, history of allergy to local anaesthetics, infection at the puncture site, unable to understand the functioning of patient-controlled analgesia (PCA) pump or numerical rating scale (NRS), and those scheduled for revision arthroplasty were excluded from the study [Figure 1]. All the patients were explained about the procedure, and written informed consent was taken for participation in the study and use of the patient data for research and educational purposes. The study followed the guidelines laid down in the Declaration of Helsinki (2013).

Patients were randomly allocated to one of the two groups using computer-generated random number tables. This group allocation was concealed in opaque envelopes which were opened on the day of the surgery. NRS and the use of the PCA device were explained to the patient on the evening before surgery. All patients were premedicated with oral 0.25 mg alprazolam on the night before surgery. On shifting the patient to the operating room (OR), standard ASA monitors were attached and maintenance fluid started. The patients received general anaesthesia in a standardized manner (intravenous fentanyl 2 microgram/kg, 2 mg/kg propofol, 0.5 mg/kg atracurium) followed by endotracheal intubation. This was followed by the administration of the block according to the group allocated to them. Patients in Group P received US-guided PENG block with 30 ml of a solution containing 0.25% bupivacaine+ with 1 mcg/kg clonidine (15 ml of 0.5% bupivacaine with 1 mcg/kg clonidine diluted with normal saline to a total volume of 30 ml).[8] Patients in Group S received a US-guided SFI block with thirty ml of a similar solution: 0.25% bupivacaine with 1 μg/kg clonidine.

PENG block was administered using a curvilinear low-frequency ultrasound probe (2–5 MHz) (USG machine Edge 2, Fujifilm Sonosite, Inc., USA) with the patient in the supine position. The probe was placed in a transverse plane over the AIIS and then aligned with the pubic ramus by rotating it clockwise/counterclockwise. The iliopubic eminence (IPE), the iliopsoas muscle and tendon, femoral artery and pectineus muscle were identified. A 22-gauge, 80-mm needle(Pajunk, Germany) was inserted from lateral to medial in an in-plane approach to place the tip in the musculofascial plane between the psoas tendon anteriorly and the pubic ramus posteriorly. Following negative aspiration, the local anaesthetic solution was injected in 5-mL increments while observing for an adequate fluid spread in this plane.

Suprainguinal fascia iliaca block was administered using a high-frequency linear USG probe (8–13 Hz) with the patient in supine position. After visualization of the femoral artery, the probe was moved laterally to visualize iliopsoas muscle and fascia iliaca. Thereafter, the probe was rotated in para-sagittal plane at the same place, and fascia iliaca was identified in the pelvis below the abdominal muscles. The needle was introduced from the 1–2 cm below the inguinal ligament in-plane to the probe directed cephalic towards the pelvis, and 30 ml of LA solution was injected below the fascia iliaca incrementally after a negative aspiration test. A gap of 20 minutes was maintained between the block (completion of local anaesthetic administration) and the surgical incision. Anaesthesia was maintained with isoflurane (1–1.1 minimum alveolar concentration) in 50% oxygen air mixture. An intubating dose of atracurium 0.5 mg/kg was used along with boluses at regular intervals. Intraoperatively, any increase in heart rate (HR) or mean arterial pressure (MAP) of more than 20% from

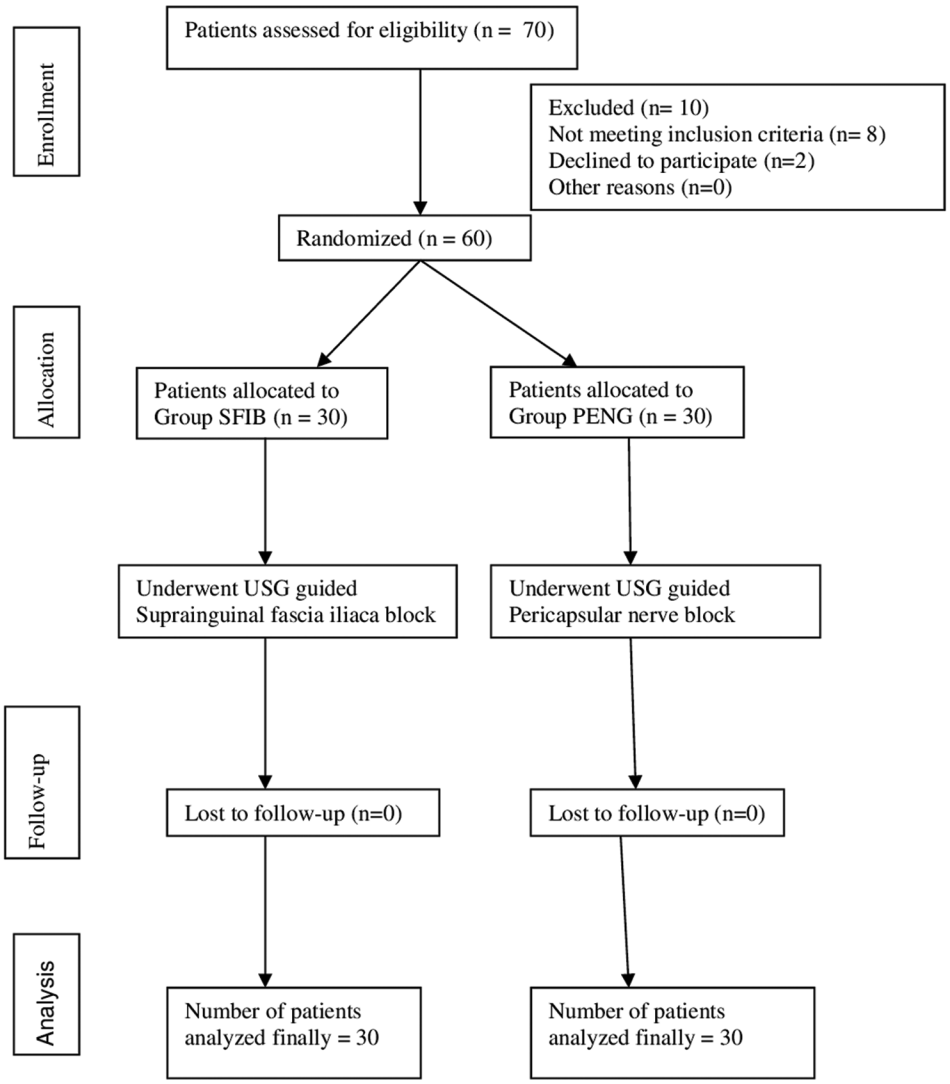

Figure 1: Consort flowchart

baseline which was not attributable to blood loss or other factors judged by a senior anaesthesiologist was managed with an additional bolus of 0.5 mcg/kg of fentanyl. At the end of the surgery, all patients were shifted to the recovery room and connected to the PCA pump with the following settings: 1 mg morphine bolus with a lockout time of 10 minutes with a maximal dose 20 mg/4 hours. In case of insufficient analgesia (NRS >4), intravenous (iv) fentanyl 0.5 microgram/kg body weight was administered by the anaesthesia resident on duty. All the patients received 1 gram iv paracetamol 6th hourly postoperatively. All the assessments were made by on-duty anaesthesia residents who were blinded to the blocks administered. Patients were also unaware of the block they received as all the blocks were given under general anaesthesia. The various assessments included morphine consumption at 24 and 48 hours, NRS at movement (nurse-assisted passive 15-degree limb lifting) at 0, 1, 3, 6, 12, 24 and 48 hours after shifting to recovery room. Quadriceps weakness was assessed at 6 hours post-surgery. The patient was made to lie in the supine position with hip flexed at 45 and knee completely flexed. The patient was asked to extend the knee against gravity and resistance. The following grading was used: Grade 0: normal muscle power (extension against gravity and resistance), Grade 1: paresis (extension against gravity but not against resistance); and 2 = paralysis (no extension).[5] Other adverse effects documented included nausea, vomiting and respiratory depression.

The primary outcome variable was 24-hour morphine consumption. The sample size of our study was calculated on basis of the study done by Desmet *et al*.[7] who compared morphine consumption after THA in

patients receiving SFIB with control. Total morphine consumption postoperatively in 24 hours in SFIB was 10.25 mg (1.26). Expecting a reduction of 15% in opioid consumption after PENG block, with an alpha error at 5% and power of 80%, the calculated sample size came to be 18 in each group. Taking dropouts and difference in standard deviation into account, we took a sample size of 30 in each group.

The data were entered in Microsoft Excel and analysed in IBM SPSS software version 23.

Normality of the data was tested using Shapiro–Wilk test. Categorical variables were presented as percentage and continuous variables as mean + standard deviation (SD) or median and interquartile range (IQR) depending on normality of data. Student's t-test was used to analyse continuous data while for categorical data Chi-square test was used. *P* values inferior to 0.05 were considered significant. Independent t-test was applied to compare analgesic intake, and pain scores between both the groups were compared with Mann–Whitney U-test.

RESULTS

Demographics and surgical characteristics were comparable in both the groups [Table 1]. Intraoperative haemodynamics (HR and MAP) was stable and comparable in both groups. The median of total morphine consumption in 24 hours and 48 hours was statistically more in SFIB group[10.0 (2.0) mg vs 8.0 (3.0) mg and 14.0 (3.0) vs 10.0 (2.0 mg)]. Patients in Group *P* reported lower postoperative pain scores [Table 2]. Also the amount of additional fentanyl which was required in 48 hours was statistically more. Compared with SFIB (5), no patient in PENG group had quadriceps weakness at 6 hours. This was statistically significant [Table 3]. None of the patients in either group had respiratory depression. Three patients in the Group *P* as compared to 5 in Group F complained of nausea which was treated with 10 mg iv metoclopramide.

DISCUSSION

This study shows that a single-shot PENG block results in less perioperative morphine consumption and reduced pain scores when compared to SFIB in patients undergoing primary THA. Also, this block offers the added advantage of no quadriceps weakness as compared to SFIB group.

Table 1: Demographic profile and surgical characteristics

Variables	Group P	Group S	*P*
Age (years)	43.20±13.61	41.03±12.74	0.527
BMI	27.07±1.96	27.30±2.07	0.656
Sex			
Male	20 (47.6%)	22 (52.4%)	0.573
Female	10 (55.6%)	8 (44.4%)	
Comorbidities			
No	16 (45.7%)	19 (54.3%)	0.729
Yes	14 (56.0%)	11 (44.0%)	
Duration of surgery (min)	124.17±7.77	126.83±9.14	0.229
Total blood loss (ml)	789.67±126.50	785.33±105.65	0.886

Continuous variables are expressed as mean and SD and categorical variables *n*. P: Pericapsular nerve block, S: Suprainguinal fascia iliaca block

Table 2: Postoperative pain scores (dynamic)*

(NRS)	Group P	Group S	*P*
0 h	3 (2-4)	4 (3-5)	<0.0001
1 h	3 (3-4)	4 (3-5)	<0.0001
3 h	4 (3-4)	4 (3-6)	0.0001
6 h	3 (2-4)	4 (3-5)	0.0002
12 h	3 (2-4)	4 (3-5)	<0.0001
24 h	2 (1-3)	4 (3-5)	<0.0001

Pain scores are presented as median (range). NRS: Numerical rating score, *Mann-Whitney *U*-test

Table 3: Postoperative outcomes

Outcome	Group P (*n*=30)	Group S (*n*=30)	*P**
Morphine consumption (mg) 24 h*	8.0 (3)	10.0 (2)	<0.001
Morphine consumption* 48 h	10.0 (2)	14.0 (3)	<0.001
Fentanyl consumption 48 h$	24.83±4.99	33.0±5.35	<0.001
Quadriceps weakness	0	5 (62.5)	0.02
Vomiting	3 (37.5)	5 (62.5)	0.448

*Mann-Whitney *U*-test. $Student's *t*-test. Continuous variables are expressed as mean±SD/median (IQR) and categorical variables as percentages

Girón-Arango *et al*.[8] described PENG block for pain management after hip fractures. Thereafter, various authors have described their clinical experience with this block in various settings: surgical anaesthesia of medial thigh, and hip reduction after hip surgery, positioning of the patients for subarachnoid block preoperatively.[10-12]

Lin *et al*.[13] in a single-centre double-blinded randomized trial compared PENG block with femoral nerve block in 60 patients undergoing hip surgery. PENG block improved postoperative analgaesia decreasing pain scores and opioid consumption during the first 48 h after surgery with better preservation of motor function. We also found similar outcomes with good analgesia and no motor weakness. This could be due to the better coverage of all the three nerves. Kukreja *et al*.[14] described 12 cases of primary or revision THA which received PENG block as an addition to SAB or GA.

Fascia iliaca block (FIB) is also a relatively new block used in THA which targets the three nerves: FN, lateral femoral cutaneous nerve (LFCN) and ON. However, studies showing no difference between FICB and sham block in patients of THA attributed it to the infrainguinal technique resulting in inadequate proximal spread of local anaesthetic.[15] Subsequently, suprainguinal approach has been described in hip surgeries.[16] Though this block reduces opioid consumption and pain scores significantly, it is also associated with quadriceps weakness.[17]

Aliste *et al*.[9] in their study stated that there was no statistically significant difference in opioid consumption or pain scores in THA patients receiving either PENG or SFIB. The incidence of quadriceps motor block was lower in patients receiving PENG block at 3 hours (45% vs 90%; $P < 0.001$) and 6 hours (25% vs 85%; $P < 0.001$). In our study, five patients who received the SFIB had quadriceps weakness at 6 hours. There was significant reduction in pain scores, and opioid consumption in patients receiving PENG block, with none of them having quadriceps weakness.

The reduction in opioid consumption could be explained by better coverage of AON and FN. Anatomical studies have confirmed that the anterior capsule is the most richly innervated section of the joint and is innervated by three main nerves (ON, AON and FN).[18] These studies also stated that the AON and FN play a greater role in the anterior hip innervation than previously reported. Radiological studies studying the cephalad spread of local anaesthetic in 3-in-1 and FIB block have stated that there is inconsistent blockade of articular branches of FN and AON.[19] The motor sparing effect in PENG block can be explained by sparing of posterior mechanoreceptors as only the sensory branches supplying the anterior capsule are targeted.[20] A recent review of histological studies has confirmed that posterior aspect of capsule has much lower density of sensory fibres than the anterior capsule.[21]

Jadon *et al*.[22] compared immediate and postoperative analgesic efficacy of PENG and SFIB in hip fracture patients. The pain significantly decreased in both the groups, but the onset of action was faster in PENG block. Also, the reduction of NRS was significantly more in PENG group when compared to SFIB group.

We administered the block after giving general anaesthesia which prevented us from assessing the onset or sensory distribution of blockade. Also, we included patients who underwent surgery via the posterior approach as this technique is used at our institute. Whether the results of this study hold true for anterior approach also needs to be studied. We have used opioids as overall analgesic in this study and did not use NSAIDs. The current trend is to minimize opioid consumption. The quadriceps weakness was also checked at only a single time point. Future studies might be planned taking these aspects into consideration.

CONCLUSION

USG PENG block significantly reduces morphine consumption, NRS scores and quadriceps weakness in THA patients when compared to SFIB block. It might prove to be a viable alternative in patients undergoing primary THA.

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Conflicts of interest
There are no conflicts of interest.

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