International Journal of
Regional Anaesthesia

Original Article

Comparative Evaluation of Varying Volumes of Local Anaesthetic Solution in Pericapsular Nerve Group Block (PENG) on Dynamic Pain Relief after Hip Surgeries

Megha Sood[1], Richa Jain[1], Gurpreeti Kaur[1], Amol Rattan[2], Mirley Rupinder Kaur[1], Rajnish Garg[2], Anju Grewal[1]

[1]Department of Anaesthesiology, Dayanand Medical College & Hospital, Ludhiana, Punjab, India.

[2]Department of Orthopaedics, Dayanand Medical College & Hospital, Ludhiana, Punjab, India.

Abstract

Background: The peri-capsular nerve group block (PENG) has reported the ability to decrease pain in hip fractures and minimize the use of opioids for postoperative analgesia. We conducted this trial to assess the efficacy of varying volumes of local anaesthetic solution in PENG block in alleviating post-operative pain at rest and on dynamic hip movement after hip surgeries.

Material & Methods: A prospective, double-blinded interventional trial was conducted on 70 adult ASA I-III patients undergoing hip surgeries under general anaesthesia. Enrolled subjects were divided into two groups A and B to receive either 10 ml of 0.2% ropivacaine or 20ml of 0.2% ropivacaine respectively in an ultrasound-guided (USG) PENG block after administration of general anaesthesia. The primary outcome was the duration of analgesia. VAS scores (at rest and on dynamic hip movement), the cumulative amount of rescue analgesic needed in the 24-hour post-operative period and patient satisfaction scores were secondary outcomes. Data thus collected were statistically analyzed.

Results: Mean duration of analgesia was significantly prolonged in group B (12.24±5.14 hours) as compared to group A (2.77±1.06 hours). There were statistically significant decreased VAS scores at rest and on dynamic hip movement in group B. Median total rescue analgesic consumption in 24 hours and patient satisfaction score was significantly reduced in group B than in group A (p=0.001).

Conclusion: In PENG block, 20 ml of 0.2% ropivacaine provides a significantly longer duration of analgesia, a statistically significant reduction in pain scores on rest and dynamic hip movement with substantially decreased 24-hour total rescue analgesic consumption, and improved patient satisfaction in patients undergoing hip surgeries.

Keywords: Pericapsular nerve group block (PENG), Hip surgeries, Ropivacaine, Visual analogue scale (VAS).

Background

Patients with hip fracture experience varying intensity of pain in the perioperative period necessitating the use of various parenteral, regional, or central neuraxial analgesic regimens.Pericapsular Nerve Group block (PENG) block as described by Giron et al [1], is a promising alternative to other peripheral nerve blocks such as femoral nerve block (FNB) or fascia iliacacompartmentblock (FICB) for analgesia in such patients [2-8].

PENG is an effective postoperative analgesic block for hip surgeries due to its reported ability to block the articular branches of the femoral, obturator, and accessory obturator nerve which supplies the anterior capsule of the hip joint [2]. By alleviating pain, PENG minimizes the use of opioids in the postoperative period. Moreover, due to minimal motor block, it enhances post-operative mobilization and hence, leads

Address of Correspondence
Dr. Richa Jain,
Department of Anaesthesiology, Dayanand Medical College & Hospital, Ludhiana, Punjab, India.
E-mail: richajain2105@gmail.com

Submitted: February 17-09-2022; Reviewed: 10-10-2022; Accepted: 12-02-2023; Published: 10-05-2023

DOI: https://doi.org/10.13107/ijra.2023.v04i01.070 | www.ijrajournal.com |

to improved outcomes. However, to date, neither the optimal volume of local anaesthetic (LA) required for PENG block reported nor has any study been published that compares different volumes of LA solution in PENG block. Also, a review of the literature revealed few RCTs to prove the validity of PENG block as an effective analgesic modality for hip surgeries. Hence we conducted a randomized double blinded study to evaluate the analgesic efficacy of varying volumes of ropivacaine 0.2% on dynamic post-operative pain relief after PENG block in patients undergoing hip surgeries under general anaesthesia.

Methods and materials

This prospective randomized clinical trial was approved by Institutional Ethics Committee (Dayanand Medical College and Hospital, Ref no DMCH/4/1-2019, dated 26-04-2022). After obtaining written informed consent, 70 ASA I, II& III, adult patients aged 18 to 80 years undergoing hip hemiarthroplasty, total hip arthroplasty, or dynamic hip screw fixation under general anaesthesia were included in the study. Exclusion criteria were coagulopathy, infection at the injection site, allergy to LA drugs, patients with opioid abuse, use of opioids for chronic analgesia, diabetic neuropathy, and patients with cognitive disability to comprehend Visual Analogue Scale (VAS).

Eligible patients were randomly allocated to either of the 2 study groups of 35 patients each by computed generated randomization codes contained in sealed, sequentially numbered envelopes. Group A patients received LA solution of 10 ml of 0.2% ropivacaine while Group B patients received 20 ml of 0.2% ropivacaine in USG-guided PENG block.

Preoperatively, demographic information including body mass index (BMI), age, gender, and type of hip surgeries was recorded. VAS at rest and on dynamic movement were noted before shifting the patient into the operating room (OR). After arrival of the patient in OR, general anaesthesia was administered under standard anaesthesia monitoring. Injection fentanyl 2 mcg/kg and dexamethasone 8 mg IV was administered at the time of anaesthesia induction in all patients. Anaesthesia was maintained using standard inhalational anaesthetic protocol keeping the vital parameters within 20% of the baseline values.

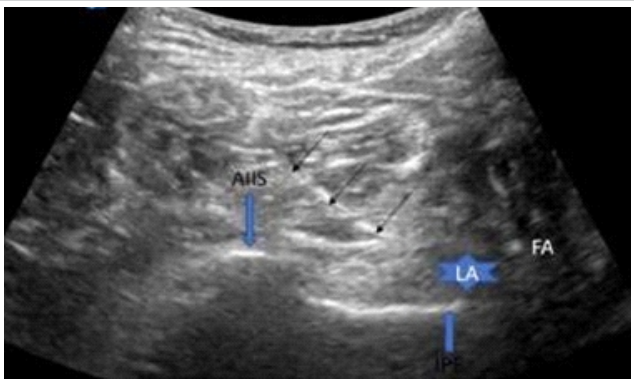

Figure 1: USG Image of PENG block showing spread of local anaesthetic between AIIS and IPE

PENG block was performed under US guidance after anaesthesia induction. A curvilinear 2-5 MHz frequency ultrasound probe (FUJIFILM SonoSite Edge II) was initially placed in a transverse plane over the antero inferior iliac spine (AIIS) and then aligned with the pubic ramus by rotating the probe counterclockwise approximately 45 degrees. In this view, the iliopubic eminence, the iliopsoas muscle and tendon, the femoral artery, and the pectineus muscle were visualised. A 21-gauge, 100 cm Stimuplex ultra 360 (B Braun Medical) needle was inserted from lateral to medial direction in an in-plane approach, to place the tip of the needle in the musculofascial plane between the psoas tendon anteriorly and the pubic ramus posteriorly. Following negative aspiration, the study drug was injected slowly while observing for an adequate fluid spread in this plane.

Intraoperatively supplemental fentanyl 0.5 mcg/kg was administered at the discretion of the attending anaesthesiologist in all patients and recorded. Surgery was initiated after the institution of the PENG block and a standard uniform technique for extubation was also followed in all patients at the end of the surgery. Additional parenteral IV analgesics were not administered toward the end of the procedure.

Both the patient and the observer were blinded to the nature of the study drug being used. The anaesthesiologist who was not involved with the direct clinical care of the patient openedthe allocation envelope and prepared the LA solution as per random allocation sequence. The sterile study drug syringes were then given to the senior anaesthesiologist performing the PENG block. On arrival to post anaesthesia care unit (PACU), a blinded anaesthesia resident assessed the following outcomes:

The primary outcome was the duration of analgesia. Duration of analgesia was defined as the time from shifting the patient to PACU to the time of the first requirement of rescue analgesic at VAS ≥4 on dynamic hip movement. Dynamic hip movement was achieved by flexion at the hip and straight leg raise of the affected limb to 15 degrees [1].

The secondary outcomes were:

1. Pain scores using VAS at rest and on dynamic hip movement postoperativelyevery hour for the first 4 hours, 2 hourly for the next 2 hours and then 4 hourly till 24 hours. The VAS score was determined by asking the patient to rate the pain from 0-10, where in 0 being the least pain and 10 being the maximum.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

2. Comparative consumption of a total amount of rescue analgesic in 24-hour post-operative period among both groups. Injection tramadol 50 i/v was used as rescue analgesic whenever the VAS ≥ 4, to a maximum of 400 mg within 24 hours [9] following which if still VAS>4 then another rescue analgesic, injection fentanyl 1 mcg/kg i/v was administered as a slow bolus.

3. Patient satisfaction score was measured by asking the patient to rate their satisfaction on a 5-point Likert scale 24 hours after surgery in PACU before shifting them to their respective ward.

Statistical analysis

Demographic data which includes age, height, weight, and BMI were described in terms of mean ±standard deviation (± SD) and analysed using Student's t-test. Duration of anaesthesia, surgery and analgesic consumption in 24 hours was described in terms of range. For comparing categorical data like gender, distribution of patients according to ASA grading, type of hip surgery and quality of block assessment by patient satisfaction score at the end of 24 hours post-operatively, Chi Square ($\chi 2$) test was performed and Fischer exact test was used when the expected frequency was less than 5. Duration of analgesia and VAS scores both at rest and on dynamic hip movement were described in terms of mean ±standard deviation (± SD) and analyzed using the Z test. A probability value (p-value) less than 0.05 was considered statistically significant. All statistical calculations were done using SPSS (Statistical Package for the Social Science) SPSS 21 version statistical program for Microsoft Windows.

Sample size calculation

It was assumed that the prevalence rate of hip surgeries in our hospital was 4.2% based on previous data. As there were no studies comparing pain reduction assumptions made were: Confidence Level = 95%, Precision (d) = ± 5%. With these assumptions,thesample size came out to be 62 patients. Accounting for a 10% dropout rate we took a sample size of 70 patients for our study. We also conducted a posthoc power analysis using G* power version 3.1.9.2 (Franzfaul, University- Kiel, Germany) software. The alpha level used for this analysis was $p < 0.05$ and the beta was 0.20. Hence using the results of the primary objective of our study (Mean duration of Analgesia) power of 1.000 was calculated.

Results

A total of 70 patients were rolled for the study and randomly allocated between two groups. All of them received the interventions and completed the study (Figure 2). Both groups were statistically comparable to the demographic data, ASA grade, and type of surgery (Table 1, 2). In both groups, the median duration of anaesthesia was 150 minutes (IQR- 120-180 minutes) and the median duration of surgery was 135 minutes (IQR- 105-165 minutes). The median duration of anaesthesia and surgery was comparable in both groups

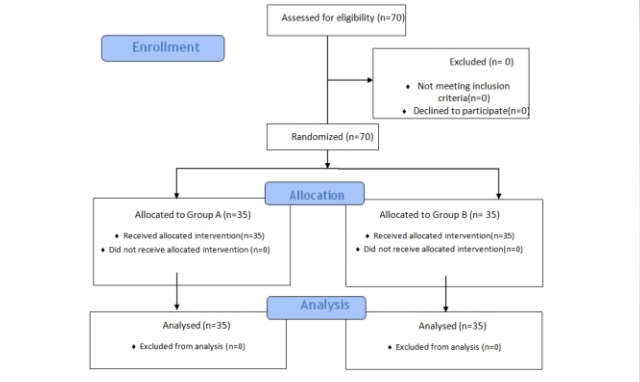

Figure 2: CONSORT Flow diagram of the study

Table 1: Patient's demographic profile (Age, height, weight, BMI)

	Group A		Group B		T	p-value
	Mean	SD	Mean	SD		
Age	49.43	14.93	55.89	17	-1.688	0.096
Height	166.97	8.11	164.97	7.47	1.073	0.287
Weight(kg)	68.2	11.32	66.09	10.44	0.812	0.419
BMI	24.34	3.62	24.2	3.18	0.168	0.867

Table 2: Patient's demographic profile (Gender, ASA grade, type of surgery)

		Group A		Group B		Total	Chi-Square value	p-value
		N	%	n	%			
Gender	F	13	37%	14	40%	27		
	M	22	63%	21	60%	43	0.06	0.806
ASA	1	9	26%	8	23%	17		
Grade	2	19	54%	21	60%	40	0.236	0.889
	3	7	20%	6	17%	13		
	Dynamic Hip Screw Fixation	1	3%	3	9%	4	1.253	0.535
	Hemiarthroplasty	11	31%	12	34%	23		
Type of Hip Surgery	Total Hip Replacement	22	66%	20	57%	43		

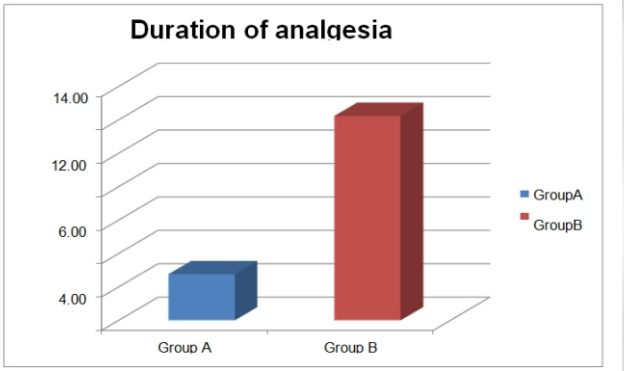

Figure 3: Mean duration of analgesia (in hours)

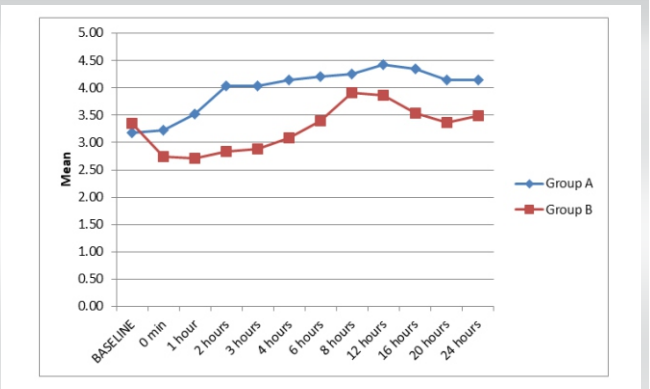

Figure 4: VAS Score at rest in both the groups

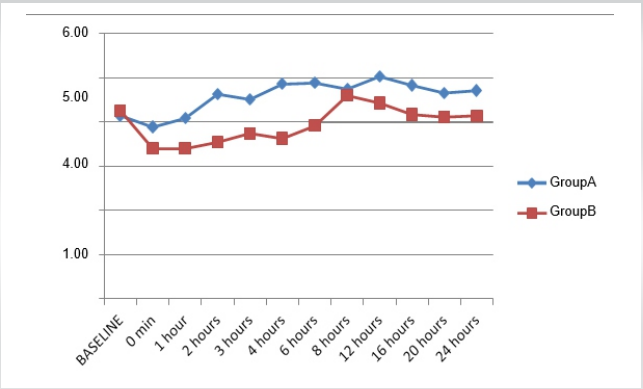

Figure 5: VAS Score on dynamic hip movements in both the groups

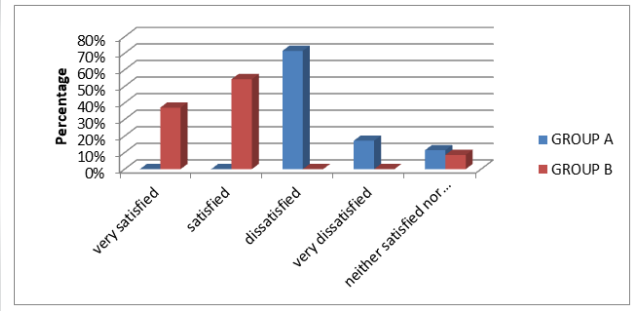

Figure 6: Patient satisfaction score

The mean duration of analgesia was 2.77±1.06 hours in group A and 12.24±5.14 hours in group B. The difference was statistically significant among both groups (Figure 3). Statistically significant reduced VAS scores were observed at rest in group B at all measurement time points of the study except at the 8th hour where the mean VAS scores were comparable in both groups (Figure 4). Statistically significant decreased VAS scores were observed on dynamic hip movement in group B at all measurement time points of the study except at the 8th hour where the mean VAS scores were comparable in both groups (Figure 5). Median values of total rescue analgesic consumption in the 24-hour post-operative period weresignificantly less in group B than in group A patients (p= 0.001). It was 150 mg (IQR:100–150 mg) in Group A compared to 50 mg (IQR : 50– 100 mg) in Group B.

In group A, 71%, 17%, and 11% of subjects were dissatisfied, very dissatisfied, and neither satisfied nor dissatisfied respectively while in group B, 37% and 54% of subjects were very satisfied and satisfied respectively with only 9% of subjects who were neither satisfied nor dissatisfied (p=0.0001) (Figure 6).

Discussion

Post-operative pain relief following hip surgeries has been a challenge for anaesthesiologists, as pain-free dynamic movements are essential for fast-tracking early rehabilitation. Peripheral nerve blocks (PNB) can efficiently reduce pain associated with hip fractures. They also contribute to reduced rates of delirium, respiratory depression, nausea, vomiting, and motor blockade which are the most common side effects seen with parenteral opioids and central neuraxial blocks [10, 11]. Recently, PENG block which targets only the articular branches of the femoral nerve (FN), obturator nerve (ON), and accessory obturator nerve (AON) was developed primarily for total hip arthroplasties for postoperative analgesia [1]. Varying volumes and concentrations of LA solution have been used successfully in the PENG block and hence the volume which could provide adequate analgesia, especially on dynamic hip movement still warrants further investigation.

We chose to use 0.2% ropivacaine due to its significantly low neurotoxic and cardiotoxic potential. In addition, it results in a lower incidence of motor blockade secondary to a greater degree of motor sensory differentiation, thereby further supporting early mobilization and safety in the post-operative period [12]. In addition we chose to conduct our study under general anaesthesia to offset any analgesic or motor block effect of spinal anaesthesia in post-operative period.Also, we administered the block immediately after induction as a means to provide preemptive analgesia. In our study, the mean duration of analgesia was significantly prolonged in group B (12.24±5.14 hours) than in group A (2.77±1.06 hours). We observed statistically significant decreased VAS scores on rest and on dynamic hip movement in group B at predominantly all measurement time points of the study in the postoperative period. In addition, the median total rescue analgesic consumption in the 24-hour post-operative period was significantly lower in group B. These findings imply superior analgesic efficacy of 20 ml over 10ml of 0.2% ropivacaine in the PENG block.

Our findings are consistent with previously published case reports and retrospective case series [1, 13, 14, 15]. Kukreja P et al administered a PENG block using 20 ml of 0.5% ropivacaine and observed lower average VAS scores in

patients undergoing primary THA as compared to pain scores after revision THA. They also reported significantly reduced cumulative oral morphine equivalent usage up to 24 hours postoperatively, thus concluding that PENG block can be used as an alternative to FNB or lumbar plexus block for primary THA [13]. Pascarella et al evaluated the impact of PENG block versus no block on post-operative analgesia and functional recovery following THA with the use of 20ml of 0.3% ropivacaine [16]. The maximum post-operative pain score and opioid consumption in patients receiving PENG block were significantly lower at all time points and were comparable to the results of our study. However, these authors included THA conducted via the posterior approach [16] while our study included all surgeries irrespective of its approach, thereby proving the versatility of the analgesic efficacy of PENG block for hip surgeries. In addition we assessed pain scores at rest and dynamic hip movement which can be considered as indirect indicators of the motor-sparing effect of PENG block.

The results of our study regarding post-operative pain scores on dynamic hip movement are in concordance to the findings of Lin D et al and Aliste J et al. The double-blinded randomised comparative trials of Lin D et al and Aliste et al utilised 20 ml of 0.75% ropivacaine and 20 ml of 0.5% levobupivacaine respectively as LA solution for PENG block while comparing them with alternative PNB's (FICB/FNB). They observed significantly less post-operative pain with better sparing of quadriceps strength in patients who received PENG block.

An ideal regional nerve block technique for hip surgery should entail a substantial reduction in dynamic pain scores along with significant opioid sparing, full preservation of motor function and a consequent higher degree of patient satisfaction.Patient satisfaction is an important parameter which reflects the quality of pain relief especially on dynamic movements. Lin D et al reported significantly improved patient satisfaction scores (97%) in the PENG group [17]. Comparable patient satisfaction scores were observed in group B of our study (91%) demonstrating the remarkable quality of enhanced pain relief achieved with 20 ml volume of LA solution.

Lin D et al and Aliste J et al reported no intergroup differences in opioid consumption upto 24-48 hours postoperative period. However, the results of our study elicited statistically significant decreased median total rescue analgesic consumption in the 24-hour post-operative periods in patients who received 20 ml of local anaesthetic solution (group B). These differences in the results for opiate consumption could be ascribed to the comparative use of different volumes of LA solutions in the two groups of our study receiving PENG block, contrary to adequate volumes of LA solutions used for both PENG and alternative comparator blocks (FNB and supra inguinal FICB) in the studies by Lin D et al and Aliste J et al. Perhaps this may indicate that 10ml of 0.2% ropivacaine used in group A of our study was inadequate necessitating use of increased dosages of rescue analgesics.

Studies by Aliste J et al and Lin D et al score our study in objectively quantifying post-operative quadriceps strength by using objective knee extension grades and hip adduction scores. Though we did not assess quadriceps strength using knee extension grades and hip adduction scores nevertheless we evaluated pain scores on dynamic hip movement (performed by asking the patients toflex at the hip and to perform a straight leg raise of the affected limb to 15 degrees) which reflects as a surrogate of quadriceps strength. We acknowledge that future studies need to employ objective grades/scores to quantify the motor-sparing effect of the PENG block.

Furthermore, the pain arising from skin incisions of hip surgeries can be diminished by blocking the lateral femoral cutaneous nerve, and lateral cutaneous branches of iliohypogastric and subcostal nerves. The addition of these nerve blocks to the PENG block may offer a painless perioperative sojourn for patients undergoing hip surgeries [18].

The limitation of our study was that we included three different types of surgeries being performed by different surgeons, thus causing the differences in surgical approach, tissue handling, and operative time which could have influenced the intensity of pain amongst our subjects.

Despite the limitations, our study design offered few advantages: All observations were carried out by a single observer to eliminate any inter-observer variability and the PENG block was administered only by three experienced consultant anaesthesiologists to all the subjects of our study. Secondly, all our patients underwent hip surgeries under general anaesthesia so we could independently evaluate the post-operative analgesic efficacy of PENG block and circumvented any confounding factors from the residual effects of central neuraxial techniques. In addition, general anaesthesia helped us in blinding the patients as well.

Conclusion

We thus conclude from the results of our study that 10 ml of lLA solution is not optimal for fascial plane block and 20 ml of 0.2% Ropivacaine in PENG block provides significantly longer duration of analgesia, a statistically significant reduction in pain scores on rest and dynamic hip movement with substantially decreased 24-hour total rescue analgesic

consumption and improved patient satisfaction in patients undergoing hip surgeries. Hence, we suggest that further studies can compare efficacy of higher volumes of LA solution in PENG block for better analgesia.

Clinical relevance

Adequate postoperative analgesia is essential to restore painless hip joints, especially in arthroplasty to provide early functional recovery and rehabilitation. PENG block provides good postoperative analgesia and early ambulation outcomes. This study will determine the efficacy of varying volumes of local anaesthetic solution in PENG block in alleviating post-operative pain at rest and on dynamic hip movement after hip surgeries.

References

[1] Girón-Arango L, Peng PWH, Chin KJ, Brull R, Perlas A. Pericapsular Nerve Group (PENG) Block for Hip Fracture. Reg Anesth Pain Med.2018;43:859-63.

[2] Morrison C, Brown B, Lin DY, Jaarsma R, Kroon H. Analgesia and anesthesia using the pericapsular nerve group block in hip surgery and hip fracture: a scoping review. Reg Anesth Pain Med. 2021;46:169-75.

[3] Guay J, Johnson RL, Kopp S. Nerve blocks or no nerve blocks for pain control after elective hip replace- ment (arthroplasty) surgery in adults. Cochrane Database of Systematic Reviews. 2017;10:CD011608.

[4] Mistry T, Sonawane KB, Kuppusamy E. PENG block: points to ponder. Reg Anesth Pain Med.2019;44:423.2–4.

[5] Roy R, Agarwal G, Pradhan C, Kuanar D. Total postoperative analgesia for hip surgeries, PENG block with LFCN block. Reg Anesth Pain Med.2019;44:684.

[6] Rocha Romero A, Carvajal Valdy G, Lemus AJ. Ultrasound-Guided pericapsular nerve group (PENG) hip joint phenol neurolysis for palliative pain. J Can Anesth.2019;66:1270–1.

[7] Ueshima H, Otake H. Clinical experiences of pericapsular nerve group (PENG) block for hip surgery. J ClinAnesth.2018;51:60–1.

[8] Acharya U, Lamsal R. Pericapsular nerve group block: an excellent option for analgesia for positional pain in hip fractures. Case Rep Anesthesiol.2020;2020:1830136.

[9] Subedi M, Bajaj S, Kumar M, MayurYC. An overview of tramadol and its usage in pain management and future perspective. BiomedPharmacother. 2019;111:443-451.

[10] De Cosmo G, Congedo E. The use of NSAIDs in the postoperative period: advantage and disadvantages. J AnesthCrit Care. 2015;4:1-10.

[11] Scottish intercollegiate Guidelines network. Management of hip fractures in older people: National Clinical Guidelines; 2009. (https://pdf4pro.com/cdn/part-of-nhs-quality-improvement-scotland-2531e4.pdf)

[12] Kuthiala G, Chaudhary G. Ropivacaine: A review of its pharmacology and clinical use. Indian J Anaesth.2011;55:104-10.

[13] Kukreja P, Avila A, Northern T, Dangle J, Kolli S, Kalagara H. A Retrospective Case Series of Pericapsular Nerve Group (PENG) Block for Primary Versus Revision Total Hip Arthroplasty Analgesia. Cureus. 2020;12:e8200.

[14] Morrison C, Brown B, Lin DY, Jaarsma R, Kroon H. Analgesia and anesthesia using the pericapsular nerve group block in hip surgery and hip fracture: a scoping review. Reg Anesth Pain Med. 2021;46:169-75.

[15] Mysore K, Sancheti SA, Howells SR, Ballah EE, Sutton JL, Uppal V. Postoperative analgesia with pericapsular nerve group (PENG) block for primary total hip arthroplasty: a retrospective study. Can J Anaesth. 2020;67:1673-4.

[16] Pascarella G, Costa F, Del Buono R, Pulitanò R, Strumia A, Piliego C, et al. Impact of the pericapsular nerve group (PENG) block on postoperative analgesia and functional recovery following total hip arthroplasty: a randomised, observer-masked, controlled trial. Anaesthesia.2021;76:1492-8.

[17] Lin DY, Morrison C, Brown B, Saies AA, Pawar R, Vermeulen M, et al. Pericapsular nerve group (PENG) block provides improved short-term analgesia compared with the femoral nerve block in hip fracture surgery: a single-center double-blinded randomized comparative trial. Reg Anesth Pain Med.2021;46:398-403.

[18] Nielsen MV, Nielsen TD, Bendtsen TF, Børglum J. The Shamrock sign: comprehending the trefoil may refine block execution. Minerva Anestesiologica. 2018;84:1423–5.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his/her consent for his/her images and other clinical information to be reported in the Journal. The patient understands that his/her name and initials will not be published, and due efforts will be made to conceal his/her identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

How to cite this article: Sood M, Jain R, Kaur G, Rattan A, Kaur MR, Garg R, Grewal A | Comparative Evaluation of Varying Volumes of Local Anaesthetic Solution in Pericapsular Nerve Group Block(PENG) on Dynamic Pain Relief after Hip Surgeries | International Journal of Regional Anaesthesia | January-June 2023; 4(1): 20-25 | DOI: https://doi.org/10.13107/ijra.2023.v04i01.070