

# Comparative Analysis of Post-Operative Analgesia and Adverse Effects with PENG Block

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## ABSTRACT

**Background:** Pericapsular nerve group (PENG) is a novel regional anesthesia technique targeting articular branches of femoral, obturator and accessory obturator nerves. It is gaining attention for its potential to provide effective analgesia for hip fractures. The present study was designed to conduct a comparative analysis of post-operative analgesia and adverse effects associated with the PENG block.

**Methods:** The study involved 50 patients aged 18-60 years, undergoing elective surgeries. Patients were divided into two groups of PENG block: RF (50mcg of fentanyl added to 30ml of 0.5% ropivacaine) and RD (50mcg of dexmedetomidine added to 30ml of 0.5% ropivacaine). Patients were administered tablets Alprazolam and Pantoprazole the night before surgery, and sensory blocks were evaluated at regular intervals until rescue analgesia and complete regression were achieved.

**Results:** The study discovered that the distribution of demographic factors, including age and gender, was comparable between the two groups. In Group RF, the male-to-female ratio was 16:9, while in Group RD, it was 20:5, with no statistically significant variation. Group RD had an ASA I/II grade of 18/7, while Group RF had an ASA grade distribution of 19/6. Group RD had sensory blockade onset faster ( $1.8 \pm 0.5$  mins) than Group RF ( $2.4 \pm 1.0$  mins). Fentanyl or dexmedetomidine added to ropivacaine enhanced postoperative analgesia, lengthened the duration of anesthesia, and improved the onset of sensory block.

**Conclusion:** Dexmedetomidine and fentanyl improve surgery readiness by shortening block onset time, prolonging sensory block duration, and extending post-operative analgesia. They also improve block quality with good sedation, making 50 µg of dexmedetomidine safe for use with ropivacaine.

**Key-words:** Hip fractures, Motor block, PENG block, Post-operative analgesia, Sensory block

## INTRODUCTION

PENG block has demonstrated considerable postoperative analgesic relief for hip fractures. PENG block has been shown in studies to lower pain intensity both at rest and during movement in elderly patients

with hip fractures, resulting in a more desirable pain reduction than standard systemic analgesia <sup>[1,2]</sup>.

Moreover, PENG block has been demonstrated to lower pain levels at different stages following surgery and during position placement, enabling quicker mobilization and better recovery of postoperative muscular strength <sup>[3]</sup>. Moreover, PENG block is safe and efficient in lowering physiological stress responses, improving pre-operative sleep quality, reducing the prevalence of cognitive impairment, and delivering early analgesia for elderly patients with hip fractures <sup>[4]</sup>. Combining PENG block with the lateral femoral cutaneous nerve (LFCN) block has also demonstrated increased pain relief and lower

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opioid use in patients undergoing local infiltration analgesia after hip fracture surgery, improving recovery outcomes [5].

The PENG block is a promising technique for managing pain in hip fracture patients, but it is essential to consider potential side effects and complications. Studies have shown that while PENG blocks can effectively reduce opioid consumption postoperatively [6], they may also lead to adverse effects such as infection, bleeding, nerve injury, and local anesthetic toxicity [7]. To manage these complications, it is crucial to ensure proper training and supervision when performing the PENG block [8]. Additionally, close monitoring for signs of infection, bleeding control measures, and using the lowest effective dose of local anesthetic can help mitigate these risks [9]. As there are few studies available about the PENG block, conducting this study may help researchers to consider this approach of nerve block for patients with hip fractures to reduce the side effects that are associated with other modes of post-op analgesia.

## MATERIALS AND METHODS

**Study place-** This prospective randomized double-blinded study was carried out in the Department of Anaesthesiology, Vydehi Institute of Medical Sciences and Research Centre, Bangalore, from January 2018 to June 2019.

To determine the sample size required for the study, the formula used was:

$$n = Z^2(1 - \alpha/2) [Z Sp^2] / d^2$$

where n represents the sample size per group, Z is the Z-score corresponding to the desired confidence level (95% in this case),  $\alpha$  is the significance level, Sp is the common standard deviation, and d is the anticipated mean difference. By plugging in the values, a sample size of 25 per group was calculated.

Using the sealed envelope procedure, 50 patients in total were divided into two groups at random. In a PENG block, Group RF received 50 mcg of fentanyl combined with 30 ml of 0.5% ropivacaine, and Group RD had a comparable block including 50 mcg of dexmedetomidine.

**Inclusion criteria-** The study included patients with American Society of Anesthesiologist (ASA) grade 1 or 2, between the ages of 18 and 60 years, for cases of neck of femur fracture, and weighing between 50 and 70 kg.

**Exclusion criteria-** The following patients were excluded from the study: those who refused the treatment, emergency cases, those with serious coagulopathies and other contraindications for PENG block, those with a history of mental illness, and those who were allergic to amide local anesthetics.

**Methodology-** Every patient had a thorough assessment during the pre-anaesthetic examination, which involved learning about their major previous and present medical and surgical histories. To evaluate the patient's general health status, a local examination and a general physical examination were performed. To establish baseline values, vital measures including height, weight, heart rate (HR), non-invasive blood pressure (NIBP), and oxygen saturation levels were evaluated. Standard tests included random blood sugar (RBS), clotting time (CT), bleeding time (BT), urine routine analysis, and complete blood count (CBC). If more research was judged required, tests such as electrocardiograms (ECG), chest x-rays, and renal function tests (RFT) were performed. Additionally, as part of the routine pre-operative protocol, all patients were given an oral tablet containing 0.5 mg of alprazolam and 40 mg of pantoprazole the night before the procedure.

On the day of operation, patients undergoing the surgery were moved to the operating room (OT) after completing preoperative assessment, pertinent research, and sufficient premedication. An injection of 4 mg of ondansetron IV, 0.03 mg/kg of midazolam IV, and 0.2 mg of glycopyrrolate IV was given to them 30 minutes before the surgery. The nurse in charge of the OT loaded the particular group of medications by random draw. The block was carried out under Siemens Acuson Freestyle Ultrasound guidance at least half an hour before the start of the procedure. An L8-3 MHz Linear Transducer and a 22G short beveled 10-cm stimuplex needle were used for localization. Based on the kind of block, patients were split into two groups: RD (50mcg of dexmedetomidine to 30ml of 0.5% ropivacaine in PENG block) and RF (50mcg of fentanyl to 30ml of 0.5% ropivacaine in PENG block). The patients' development of the sensory block was assessed every five minutes for thirty minutes. After 30min of PENG block, the patient was given spinal in sitting position with 3ml of 0.5% bupivacaine heavy. Surgery was started following spinal anaesthesia.

During the evaluation of sensory block in patients undergoing surgery, a pin prick test was utilized with a 3-point scale system. A score of 0 indicated the presence of sharp pain. In contrast, a score of 1 signified only touch sensation being felt (analgesia), and a score of 2 indicated no sensation being felt (anaesthesia) in different nerve territories. From the time of pre-surgery to the post-surgery period, both sensory and motor blocks were assessed regularly until the first rescue analgesia was needed and the block completely receded. Furthermore, patients were asked to self-report their subjective level of recovery about sensation, pain threshold, and range of motion.

Following surgery, the patient was watched over nonstop until the pain started, and the moment rescue analgesia was administered for the first time was noted. A standardized visual analogue scale (VAS) was used to measure pain at predetermined intervals, namely 0, 2, 4, 6, 9, 10, 12, and 14 hours after surgery or until the patient reported pain. When the VAS score was equal to or higher than 3, the nursing staff was directed to give the first rescue analgesic, Inj. Diclo One–AQ (diclofenac sodium), 75 mg IV. Inj. Supridol (Tramadol) 50 mg IV was used as a second rescue analgesic if the pain was not sufficiently managed with the first dosage. Any side effects from the operation or study medications, such as pruritus, bradycardia, hypotension, sedation, respiratory distress, nausea and vomiting were recorded.

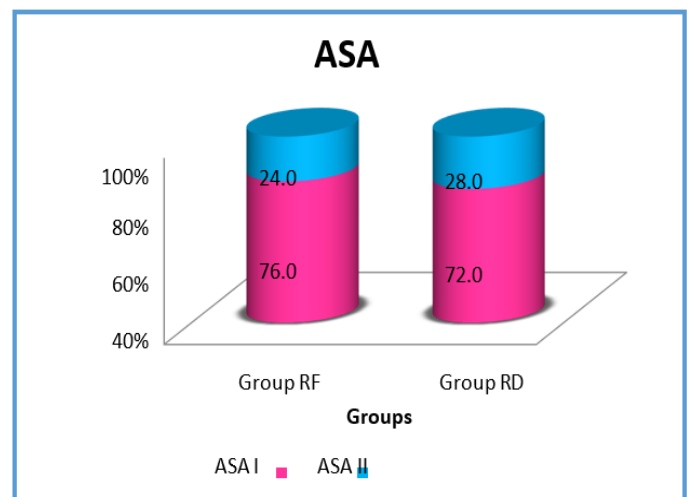
**Statistical Analysis-** IBM SPSS Statistics software version 23.0 was used to evaluate the data after it was obtained using Microsoft Excel. Tables, graphs, proportions, and percentages were used to display the results. Descriptive statistics like frequency analysis and percentage analysis were utilized for categorical variables, whereas mean and standard deviation (S.D.) were used for continuous variables. The unpaired sample t-test and Mann-Whitney U test were used to compare bivariate samples in separate groups and find significant differences. The Chi-Square test was utilized to examine the significance of categorical data; however, Fisher's exact test was applied in 2x2 tables where the predicted cell frequency was less than 5. In every statistical analysis, a p-value of less than 0.05 was deemed statistically significant.

**Ethical Approval-** The study was conducted with prior approval from Vydehi Institutional Ethics Committee and

written informed consent was obtained from all the patients.

## RESULTS

The 50 patients that were included in this study had similar distributions of ASA grades, ages, and genders. The mean age of Group RD was  $35.0 \pm 11.6$ , while the mean age of Group RF was  $36.6 \pm 13.5$ . There was no statistically significant difference between the two groups ( $p > 0.05$ ). There was no statistically significant difference between Group RD and Group RF in terms of the male-to-female ratios (16:9 and 20:5, respectively;  $p > 0.05$ ). Furthermore, Group RD had 18/7 patients in the same categories as Group RF, but Group RF had 19/6 patients in the same categories. The distribution of ASA I and II did not differ statistically significantly ( $p > 0.05$ ) between the two groups (Fig. 1).



**Fig. 1:** Comparison of ASA Grade I / II between two groups.

Group RD experienced a substantially faster onset of sensory blockage ( $1.8 \pm 0.5$  minutes) than Group RF ( $2.4 \pm 1.0$  mins) in the comparison between the two groups.  $p < 0.01$  indicated a highly statistically significant difference. Furthermore, Group RD took significantly less time ( $12.6 \pm 3.7$  mins) to achieve total sensory blocking than Group RF ( $16.3 \pm 2.9$  mins), with a  $p < 0.01$ , indicating a high statistical significance between the two groups. Additionally, with a  $p < 0.01$  (Table 1), the duration of sensory blockage was substantially longer in Group RD ( $623.5 \pm 63.0$  mins) than in Group RF ( $490.6 \pm 65.2$  mins).

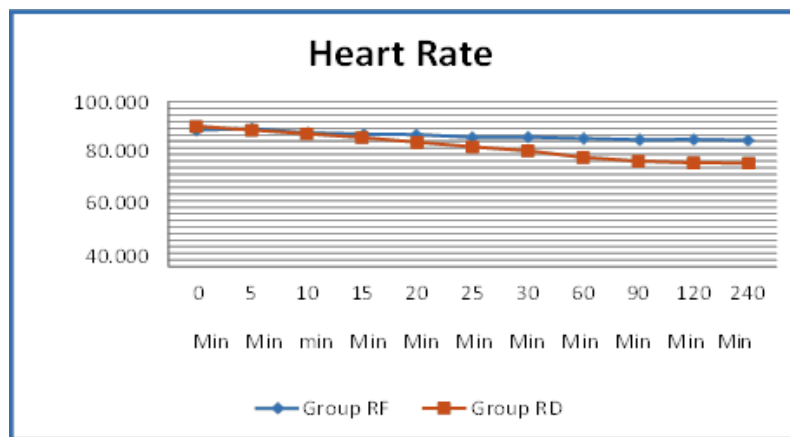
**Table 1:** Onset, time to complete and duration of sensory block in group RF and group RD.

Variables	Group RF	Group RD	p-value
Onset of sensory block (min)	2.4±1.0	1.8±0.5	0.008**
Time to complete sensory block (min)	16.3±2.9	12.6±3.7	0.0005**
Total duration of sensory block (min)	490.6±65.2	623.5±63.0	0.0005**

**\*\*Highly significant at  $p < 0.01$  level**

The average heart rate patterns show that both groups stayed below the average baseline levels. None of the patients in Group RD or Group RF experienced bradycardia. Still, the difference in mean heart rates from the corresponding preoperative mean baseline

values was found to be statistically significant ( $p < 0.01$ ) in Group RD. The difference became statistically significant after a 25-minute interval. As the sensory level declined, HR recovered to its preoperative mean levels (Fig. 2).



**Fig. 2:** Trends in heart rate.

Table 2 presents a comparison of sedation scores among the two groups. The table shows the distribution of sedation scores across three categories: I, II, and III. In Group RF, there were 25 individuals in Category I with a sedation score of 0, representing 100% of that group. In Category II, there were no individuals from Group RF,

while in Category III, 19 individuals accounted for 76% of the group. On the other hand, in Group RD, there were 6 individuals in Category II (24%) and 19 individuals in Category III (76%). The statistical analysis indicated a highly significant difference between the two groups at a p-value of 0.0005.

**Table 2:** Comparison between sedation scores with groups.

			Groups		Total	Z- value	p-value
			Group RF	Group RD			
Sedation Score	I	Count	25	0	25	50	0.0005**
		%	100	0	50		
	II	Count	0	6	6		
		%	0	24	12		
	III	Count	0	19	19		
		%	0	76	38		
Total		Count	25	25	50		
		%	100	100	100		

**\*\*Highly significant at  $p < 0.01$  level**

The VAS scores for Group RF and Group RD at various time intervals were compared using the Mann-Whitney Test (Table 3). The findings show that, at VAS 2, there were no statistically significant variations in the VAS ratings between the two groups. On the other hand, Group RF outperformed Group RD at VAS 6, VAS 8, VAS

9, and VAS 12. In particular, the difference was extremely significant at VAS 8, VAS 9, and VAS 12, with p-values of 0.0005, while the difference at VAS 6 was statistically significant with a p-value of 0.039. This implies that at these time points, Group RF likely had far more pain or suffering than Group RD.

**Table 3:** VAS comparison of group RF and RD by Mann-Whitney test.

Groups		Mean	S.D	Z-value	p-value
VAS 2	Group RF	0	0.0	0	1.000 <sup>#</sup>
	Group RD	0	0.0		
VAS 4	Group RF	0.08	0.40	1	0.317 <sup>#</sup>
	Group RD	0	0.00		
VAS 6	Group RF	0.48	1.23	2.062	0.039*
	Group RD	0	0.00		
VAS 8	Group RF	1.88	1.62	5.13	0.0005**
	Group RD	0	0.00		
VAS 9	Group RF	4.08	1.12	6.32	0.0005**
	Group RD	0.2	0.58		
VAS 12	Group RF	4.88	0.44	2.819	0.005**
	Group RD	4.36	0.76		

\*Statistical significance at  $p < 0.05$  level,

\*\*Highly significant at  $p < 0.01$  level,

<sup>#</sup>No statistical significance at  $p > 0.05$  level,  $N = 25$

The frequency of adverse effects seen in two groups, according to the findings, neither group experienced any episodes of hypotension, bradycardia, respiratory distress, nausea, or vomiting. On the other hand, none in the RF group and 19 instances in the RD group had reports of sedation at Grade 3. At a p-value of 0.0005, the difference was determined to be very significant, suggesting a strong correlation between the treatment and sedation at this severity level.

## DISCUSSION

Ropivacaine, a local anesthetic classified as an amino-amide, shares similarities with bupivacaine in terms of onset and duration of block. However, it is less lipophilic than bupivacaine and exhibits lower toxicity in cases of accidental intravascular injection. Studies have shown that ropivacaine has a notably higher threshold for cardiotoxicity and central nervous system (CNS) toxicity compared to bupivacaine when unintentional intravascular injection occurs in both animal models and healthy volunteers. Despite these advantages, ropivacaine is recognized for its efficacy in

peripheral nerve blocks. Nevertheless, one limitation of ropivacaine is its inferior motor effect compared to bupivacaine. To address this issue, adjuvants such as Fentanyl and Dexmedetomidine are often incorporated to enhance the quality of anesthesia and prolong the duration of sensory and motor blocks <sup>[10]</sup>. Research has indicated that elevating the ropivacaine concentration from 0.5% to 0.75% does not result in enhanced block onset or duration. Furthermore, repeated analgesics and replenishment are frequently required when using 0.25% ropivacaine for subclavian perivascular brachial plexus block <sup>[11]</sup>. To overcome these drawbacks, scientists have investigated the use of adjuvants in conjunction with local anesthetics to improve the timing and efficacy of motor and sensory blocking to provide adequate surgical anesthesia <sup>[12,13]</sup>.

Essential insights are revealed by comparing post-operative analgesia and side effects with the PENG block. Research indicates that adequate postoperative analgesia and functional recovery following total hip arthroplasty (THA) can be achieved by combining PENG block with either wound infiltration (WI) or LFCN block



<sup>[14]</sup>. Additionally, research comparing levobupivacaine and ropivacaine in PENG blocks for hip fractures demonstrated comparable analgesic duration and quality, with a low need for rescue analgesics and minimal adverse effects <sup>[15]</sup>. Furthermore, investigations on the dose of ropivacaine in PENG blocks highlighted that reducing the volume to 10 mL of 0.5% ropivacaine can lower the incidence of motor block, suggesting an optimal administration approach for improved outcomes <sup>[16]</sup>. Overall, these findings emphasize the efficacy of PENG blocks in providing postoperative pain relief with minimal adverse effects, supporting its use as a valuable technique in THA procedures.

### LIMITATIONS

The limitations of our study primarily revolve around the lack of specific crucial data points and participant demographics. Firstly, a significant limitation is that we did not measure the plasma levels of the study drugs during the research. This absence of direct measurement of drug concentrations in the plasma could potentially impact the accuracy and reliability of our findings. Additionally, another notable limitation is that specific demographic groups were excluded from the study, namely patients in the paediatric and geriatric age groups. The exclusion of these age categories limits the generalizability of our results, as responses to medications can vary significantly across different age ranges due to physiological differences and varying drug metabolism rates. Furthermore, another critical group not included in our study were patients classified as ASA III and above. Excluding patients with higher ASA classifications could skew our findings, as these individuals may have underlying health conditions or comorbidities that could influence their response to the study drugs differently compared to healthier individuals.

### CONCLUSIONS

In conclusion, dexmedetomidine and fentanyl both enhance the readiness for surgery. Dexmedetomidine not only shortens the onset time of block but also prolongs the duration of sensory block, along with extending post-operative analgesia. Additionally, dexmedetomidine improves the quality of the block with suitable sedation compared to fentanyl when used as an adjuvant to ropivacaine in PENG block. Therefore, the

safe use of 50 µg of dexmedetomidine as an adjuvant to 30 ml of 0.5% ropivacaine without significant side effects is recommended. Future work is required to explore the potential of combining dexmedetomidine and fentanyl with other local anesthetics to improve block characteristics and patient outcomes further.

### CONTRIBUTION OF AUTHORS

**Research concept-** Prashanth Prabhu J, Natesh S Rao

**Research design-** Prashanth Prabhu J, Natesh S Rao

**Supervision-** Swetha AN

**Materials-** Prashanth Prabhu J, Natesh S Rao

**Data collection-** Prashanth Prabhu J, Natesh S Rao

**Data analysis and Interpretation-** Prashanth Prabhu J, Natesh S Rao

**Literature search-** Prashanth Prabhu J, Natesh S Rao

**Writing article-** Prashanth Prabhu J, Natesh S Rao

**Critical review-** Swetha AN

**Article editing-** Prashanth Prabhu J, Natesh S Rao

**Final approval-** Swetha AN

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