EFEKTIVITAS ANALGESIA *PERICAPSULAR NERVE GROUP BLOCK* PASCAOPERASI PADA PASIEN YANG MENJALANI *TOTAL HIP REPLACEMENT* DENGAN ANESTESI REGIONAL *SUBARACHNOID BLOCK*

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ABSTRAK

Penggunaan blok saraf kelompok perikapsular (PENG) dapat menjadi alternatif analgesia post-operatif yang efektif untuk Penggantian Sendi Panggul Total, dengan komplikasi rendah. Penelitian ini bertujuan untuk menentukan efektivitas analgesia blok PENG terhadap tingkat nyeri, jumlah konsumsi opioid dalam 24, 48, dan 72 jam serta analgesia post-operatif THR di Rumah Sakit Prof. Dr. I. G. N. G. Ngoerah Denpasar. Penelitian ini adalah studi eksperimental dengan desain uji acak terkontrol buta tunggal yang dilakukan di ruang operasi Instalasi Bedah Sentral Rumah Sakit Prof. Dr. I. G. N. G Ngoerah, Denpasar. Uji perbandingan rata-rata menggunakan uji Mann-Whitney jika distribusi data tidak normal. Seluruh proses analisis data di atas menggunakan perangkat lunak statistik SPSS 26. Ada 48 subjek yang menjalani THR dan dibagi menjadi 2 kelompok. Ada perbedaan yang signifikan secara statistik antara kelompok-kelompok tersebut. Berdasarkan hasil analisis non-parametrik, NRS saat istirahat dan bergerak di kelompok perlakuan lebih rendah daripada kontrol dengan nilai p <0,001. Jumlah opioid yang diperoleh memiliki nilai p <0,001 dalam 24 jam pertama, 48 jam, dan 72 jam. Durasi efek ditemukan lebih lama pada kelompok PENG dibandingkan dengan kontrol (p <0,001). Pemberian blok PENG selama prosedur THR menghasilkan NRS yang lebih rendah pada 24 jam, penggunaan opioid yang lebih rendah pada 24 jam, 48 jam, dan 72 jam pascaoperatif, dan durasi efek bebas nyeri yang lebih lama.

Kata kunci **:** analgesia, blok saraf kelompok perikapsular, penggantian sendi panggul total, skala rating numerik

ABSTRACT

The use of Pericapsular Nerve Group Block (PENG) peripheral nerve blocks can be an effective alternative to post-operative analgesia for Total Hip Replacement, with low complications. This study aims to determine the effectiveness of PENG block analgesia on the degree of pain, the amount of opioid consumption in 24, 48 and 72 hours as well as post-operative THR analgesia at Prof. Hospital. Dr. I. G. N. G. Ngoerah Denpasar. This research is an experimental study with a single-blind randomized controlled trial design conducted in the operating room of the Central Surgical Installation of Prof.Dr.I.G.N.G Ngoerah Hospital, Denpasar. The mean comparison test uses the Mann-Whitney test if the data distribution is not normal. The entire data analysis process above uses SPSS 26 statistical software. There were 48 subjects who underwent THR and were divided into 2 groups. There were statistically significant differences between groups. Based on the results of non-parametric analysis, the NRS at rest and movement in the treatment group was lower than the control with a p value <0.001. The amount of opioid obtained had a p value <0.001 in the first 24 hours, 48 hours and 72 hours. The duration of effect was found to be longer in the PENG group compared to controls (p<0.001). Giving PENG block during THR procedures resulted in lower NRS at 24 hours, lower opioid use at 24 hours, 48 hours and 72 hours postoperatively and a longer duration of pain-free effect.

Keywords ***:*** *pericapsular nerve group block, total hip replacement, numerical rating scale, analgesia*

INTRODUCTION

Total Hip Replacement (THR) procedure is one of the commonly performed procedures by orthopedic surgeons, especially in patients experiencing hip joint disorders due to injury, aging processes, or inflammatory conditions that cannot be managed with other treatments. The selection of appropriate postoperative analgesia plays a role in the process of patient mobilization speed. The most commonly used postoperative analgesia technique for THR is intravenous opioid administration or epidural neuroaxial anesthesia. Complications from the use of opioids or epidurals can affect the patient's recovery process. The use of Pericapsular Nerve Group Block (PENG) as one of the effective multimodal postoperative analgesia alternatives for THR, with fewer complications compared to the use of opioids and epidurals, can facilitate patient comfort and better hemodynamic stability.

The most common etiology of hip bone fractures is osteoporosis. Limited data from five hospitals in Indonesia showed that treatment for hip bone fracture cases can take 10-14 days (Dhingra et al., 2009). One of the reasons for the prolonged treatment of patients with hip bone fractures is pain, where if this pain is not well managed, it can risk developing into chronic pain (Basques et al., 2015). In the United States, opioids are still the choice for acute postoperative pain for some orthopedic procedures including THR (Gaffney et al., 2017). A study of 574 patients undergoing Total Knee Arthroplasty (TKA) and THR found that 4.3% of patients still used opioids within 6 months, with 34.7% reported using opioids after 6 months of the surgical procedure (Goesling et al., 2016). Opioids have side effects including nausea, vomiting, pruritus, ileus, cardiovascular and respiratory disturbances (Sing et al., 2016). Epidural is another option besides intravenous opioid use, but potential side effects such as hypotension, Post Dural Puncture Headaches (PDPH), motor block, and the most feared complication is epidural hematoma need attention (Young & Buvanendran, 2014). All these side effects undoubtedly make it difficult for patients to mobilize earlier, thereby prolonging hospitalization and increasing treatment costs.

Research conducted by Eugenia in 2020 on the characteristics of pain in 195 orthopedic postoperative patients at Prof. Dr. I.G.N.G Ngoerah Hospital based on pain management found that the most commonly used was a combination of intravenous opioids and paracetamol by 33%, while the second was a combination of epidural with opioids and paracetamol by 24%, the rest were combinations of paracetamol with Nonsteroidal Anti-inflammatory Drugs (NSAIDs) or paracetamol with peripheral nerve blocks below 10%. Opioids, the primary choice for analgesia, whether used in combination or not, certainly increase the risk of Postoperative Nausea and Vomiting (PONV), often found in cases of postoperative THR (Wang et al., 2020).

Given the numerous side effects associated with opioid or neuroaxial epidural use, there is a need for new alternative analgesic techniques with fewer side effects but can provide adequate analgesia. Peripheral nerve block techniques as postoperative multimodal analgesia can be used as alternatives, one of which can be used in this case is the Pericapsular Nerve Group Block (PENG). PENG block may help reduce postoperative pain, opioid use, and other risks associated with postoperative opioid and neuroaxial block use (Laumonerie et al., 2021).

The role of anesthesiologists in the management of lower extremity postoperative, particularly THR, is significant. Anesthetic techniques aim to help alleviate pain during and after surgery. Pain management modalities are also expected to reduce hemodynamic disturbances that may occur, especially in elderly patients, which are most common in this case (Knott et al., 2020). These patients are a vulnerable age group with increased risk of perioperative and postoperative complications due to heart, respiratory, and neurological problems. If pain is not well managed, it will be associated with increased risks such as delirium, prolonged hospitalization, poor patient quality of life, and chronic pain (Agustí et al.,

2023). Peripheral nerve blocks have been proven safe to use even in patients requiring thromboprophylaxis after joint arthroplasty. In approximately 7000 procedures in patients receiving warfarin, aspirin, fondaparinux, dalteparin, and enoxaparin, no perineural hematoma was recorded in continuous lumbar plexus, femoral and sciatic continuous or single blocks (Chelly & Schilling, 2008). The common neurological complications frequently encountered in central nerve blockades were reported to be below 0.04%, and the rate of neuropathy after peripheral nerve blockades was below 3%, and even fewer causing permanent nerve damage (Brull et al., 2007).

With the development of ultrasound technology alongside anatomical knowledge, it has facilitated new anesthesia and analgesia techniques for hip bone fracture cases. Old techniques like lumbar plexus block, sciatic block, and iliopsoas fascia block usually do not affect all sensory nerves innervating the joint and cause motor blocks leading to longer mobilization times. PENG block provides more optimal analgesia without disrupting motor function (Kukreja et al., 2023).

The anterior hip capsule has a high density of nociceptors and mechanoreceptors and is the main source of pain after hip surgery. PENG block targets articular branches innervating the anterior capsule of the hip joint, including the femoral, obturator, and accessory obturator nerves. The potential for motor-sparing effects is desired for early ambulation, better physical therapy, and faster recovery. The potential analgesic benefits provided by this block, without interfering with motor function, may have a positive impact on overall patient mood, sleep, appetite, and well-being (Kukreja et al., 2023).

Based on research conducted by (Agustí et al., 2023) regarding the benefits of PENG block, where this block provides analgesia and reduces patient pain scores by 3 points compared to if this block is not performed. Patient hemodynamics also remained stable during treatment. Postoperative pain and other complications were also not encountered. The same study was also conducted by (Kukreja et al., 2023) on 112 patients regarding the quality of recovery in post-THR patients, it was found that patients who underwent PENG block had better healing quality (132[116-138]) compared to those who did not undergo PENG block (103[97-112]) with a median difference of 26 (95% confidence interval, 18-31; $P<0.001$) and significantly lower opioid use in the PENG block group. A systematic review and meta-analysis between PENG block and Fascia Iliaca Compartment (FI) block conducted by (Barbhaiya et al., 2023) on 8 articles involving a total of 384 patients, where 196 (51%) underwent PENG block after hip surgery, PENG block reduced pain scores 12 hours postoperatively (MD=0.61 mm; 95% CI 1.12 to -0.09; $P=0.02$) and reduced opioid consumption 24 hours postoperatively compared to FI block (MD=-6.93 mg; 95% CI -13.6 to -0.25; $P=0.04$).

Reports of adverse events with PENG block are very few, side effects are more related to occurrences of quadriceps muscle weakness due to femoral nerve and fascia iliaca (FI) blockade, caused by needle placement too deep and medial, as well as toxicity from local anesthetic drugs. These events are rare and their risk can be reduced by using ultrasound assistance and not exceeding the maximum dose of local anesthetic drug usage (Wiseman & O'Riordan, 2022). Based on the data obtained from the medical records of Prof. Dr. I.G.N.G Ngoerah Hospital from January 2022 to November 2023, the use of PENG block as postoperative analgesia for THR has never been performed. The combination of opioids and epidurals remains the frequently performed option, prompting researchers to test the effectiveness of using this block as an alternative multimodal analgesia besides opioid or epidural combinations at Prof. Dr. I. G. N. G. Ngoerah Hospital in THR surgery. The aim of this study is to determine the effectiveness of PENG block analgesia on pain intensity, opioid consumption within 24, 48, and 72 hours, as well as postoperative analgesia following THR at Prof. Dr. I. G. N. G. Ngoerah Hospital in Denpasar.

METHOD

This study is an experimental research with a single-blind randomized controlled trial design, as the subjects are unaware of the allocation of the research groups. The study divides subjects into two groups: the group undergoing PENG block post-THR surgery with regional anesthesia BSA as the treatment group, and the group not undergoing PENG block but only receiving regional anesthesia BSA as the control group. To allocate subjects into the treatment or control groups, randomization will be conducted. The type of treatment given will be concealed (blinded) from the participants, while the researcher will know the intervention received by the subjects after randomization of group allocation.

This research was conducted in the operating room of the Central Surgical Installation at Prof. Dr. I.G.N.G Ngoerah Hospital in Denpasar, Indonesia, from February 2024 to March 2024. The target population of this study comprises patients undergoing Total Hip Replacement (THR) surgery with regional BSA anesthesia at Prof. Dr. I.G.N.G Ngoerah Hospital. The accessible population includes all patients undergoing Total Hip Replacement (THR) surgery with BSA anesthesia in the operating room of the Central Surgical Installation at Prof. Dr. I.G.N.G Ngoerah Hospital.

The sampling frame for this research includes a specific selection of subjects from the accessible population who meet certain eligibility criteria. Inclusion criteria involve patients with ASA physical status I to III, aged between 18 and 65 years, and with a BMI ranging from 18.5 to 35 kg/m². Exclusion criteria consist of patients contraindicated for regional anesthesia, those with mental disorders, history of allergies to anesthetic drugs to be used, coagulopathy, or refusal by patients or their families to participate in the study. Drop-out criteria include failed spinal anesthesia technique requiring a change, hemodynamic disturbances with hypotension exceeding 30% from baseline necessitating continuous vasopressor use, patient mortality during the study, or postoperative ventilator use.

The sample size calculation is based on a formula for non-paired numerical analytical research (Dahlan, 2009). With a type I error rate (α) set at 5%, Zα is 1.65 (one-tailed hypothesis). A power of 95% yields a Zβ value of 1.64. Given a clinically significant difference of 2 in pain scores between groups, as per a study by Iglesias et al. (2023), the sample size is determined as follows: $n1=n2= 21.6 \approx 22$. Similarly, with a clinically significant difference of 6 in opioid requirement between groups, as per a study by Domagalska et al. (2023), the sample size is calculated as follows: $n1=n2= 2.5 \approx 3$. Additionally, with a clinically significant difference of 5 in the duration of analgesia effect between groups, also based on Domagalska et al. (2023), the sample size is determined as follows: $n1=n2= 3.5 \approx 4$. Based on these formulas, the required sample size for each analysis is determined. Considering a 10% dropout rate due to anesthesia technique failure, the total minimum sample size for the study is adjusted accordingly.

The sampling technique employed in this study was consecutive sampling, where subjects were selected based on their arrival order until the required sample size of a total of 48 samples was met. This study employed sample allocation by dividing subjects into control and treatment groups using block randomization method through Quickcalcs (Graphpad, Software, Inc). Group P received post-THR surgery PENG block, while group K received intravenous opioids post-surgery. Random numbers were placed in sequentially sealed opaque envelopes and coded. The envelopes were prepared by a third party not involved in the research and were opened before patients signed written consent and before the procedure.

This study adopts a single-blinded approach, where various measures are implemented to ensure participant blinding throughout the research process. Firstly, both participants in the research groups are provided with identical explanations and informed consent procedures, thereby preventing them from discerning their allocation group and the subsequent data

collection procedures. Secondly, prior to the operation, the attending anesthesiologist opens sealed envelopes containing intervention details, ensuring that the participants remain unaware of their treatment group. Following the surgical procedure, participants in both groups undergo similar post-operative protocols, such as nerve identification using ultrasound, maintaining participant blinding regarding the received intervention. Lastly, research data, including numerical variables such as NRS scores, opioid requirement, and duration of analgesic effect, are collected by the researcher post-operation, thereby upholding the single-blinded nature of the study.

The collected data underwent statistical analysis using computer software. A significance level of $p<0.05$ was deemed meaningful, with the following analytical steps: descriptive Analysis: Aimed at depicting subject characteristics and research variables based on treatment groups. Numeric data variables were presented with mean and standard deviation (SD) if normally distributed, and median and interquartile range if not normally distributed. Categorical data variables were presented with relative frequencies. Descriptive statistical analysis results were presented in tables. Normality Test: Conducted to ascertain whether the sample distribution of pain scale at 24 hours, intravenous opioid requirement within 24, 48, 72 hours, and postoperative analgesic effect duration were normally distributed. Analysis of pain scale data utilized the Shapiro-Wilk test at a significance level of 0.05, where data were considered normal if $p>0.05$ and non-normal if $p\leq 0.05$. Mean Comparison Test: Employed independent t-tests for normally distributed data or Mann-Whitney tests for non-normally distributed data. The effectiveness of the block based on the pain scale at 24 hours post-operation, intravenous opioid requirement, and postoperative analgesic effect duration was assessed based on mean differences. The overall data analysis process was conducted using SPSS 26 statistical software.

RESULTS

Characteristics of the Study Data

In this study, there were 48 subjects undergoing THR, with 24 patients receiving PENG block with regional anesthesia BSA (P) and 24 patients not receiving it (K). The observed subject characteristics included categorical variables such as gender and ASA physical status, as well as numerical variables such as age and BMI.

Table 1. Characteristics of Research Data

Characteristic	Group		p-value
	Treatment (n=24)	Control (n=24)	
Age (years)	42,92 (±16,22)	52,67 (±13,54)	0,160T
Gender (%)			0,141C
Male	15 (62,5)	10 (41,7)	
Female	9 (37,5)	14 (58,3)	
IMT (kg/m2)	23,67 (±2,84)	23,58 (±3,12)	0,180T
Physical Status			0,323C
ASA I	7 (29,2)	2 (8,3)	
ASA II	8 (33,3)	6 (25,0)	
ASA III	9 (37,5)	16 (66,7)	

In this study, demographic data between groups were compared. Differences between categorical variables were analyzed using cross-tabulation and Chi-Square test with Pearson's correlation to assess data distribution, resulting in a normal distribution ($p > 0.05$). The comparison between the two groups yielded p-values greater than 0.05, indicating no significant differences between the data sets. Thus, based on these findings, further

comparative analysis can be conducted as both groups are in equivalent conditions. Based on Table 5.1, statistical analysis indicates no statistically significant differences between the treatment and control groups, both in categorical characteristics such as gender and ASA physical status, as well as in numerical characteristics such as age and BMI.

Comparison of NRS Scores at 24 Hours in Resting and Moving States in Both Groups

In this study, the pain scale was assessed using the Numeric Rating Scale (NRS) at rest and during movement in the group with PENG block and the group without PENG block. Before comparing the two groups, a normality test was conducted to assess whether both sets of data were normally distributed.

Table 2. NRS Scores During 24 Hours Postoperative

Characteristics	Group		Normality test[1]	p-value
	Treatment (n=24)	Control (n=24)		
NRS 24 hours				
Resting	1,75 (±0,53)	4,33 (±0,92)	<0,001	<0,001
Moving	3,21 (±0,66)	7,00 (±0,72)	<0,001	<0,001

Based on table 2 the normality test on the analyzed numeric variables using the Shapiro-Wilk test showed that the data for both Resting NRS and Moving NRS were not normally distributed ($p<0.05$). Consequently, a non-parametric test, specifically the Mann-Whitney test, was employed to determine whether there was a significant difference in these variables between the two intervention groups. The non-parametric analysis of Resting NRS in the treatment group, 1.75 (±0.53), compared to the control group, 4.33 (±0.92), resulted in a p-value <0.001, indicating a significant difference. This suggests that the treatment group had lower Resting NRS compared to the control group.

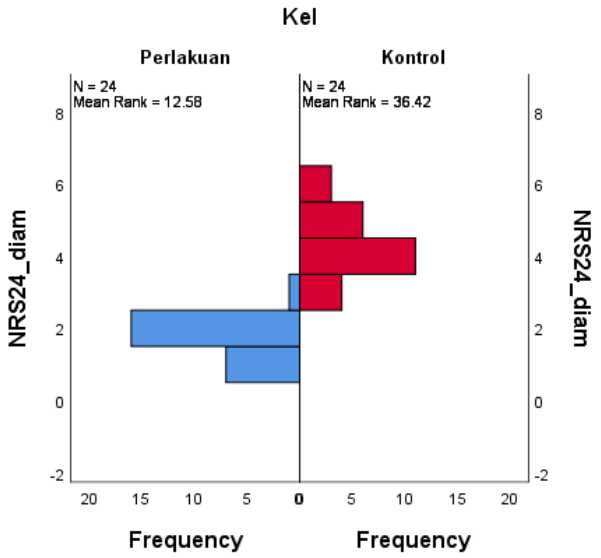


Figure 1. Difference in Resting NRS between Treatment and Control Groups

Based on the data, the mean score of NRS during movement at 24 hours post-operation in the treatment group was 3.21 (±0.66) and in the control group was 7.00 (±0.72). The normality test yielded a value of <0.001, indicating non-normal distribution of the data, thus necessitating non-parametric analysis. The Mann-Whitney test resulted in a value of <0.001, indicating a significant difference. Therefore, it can be concluded that the NRS during movement in the treatment group is lower compared to the control group.

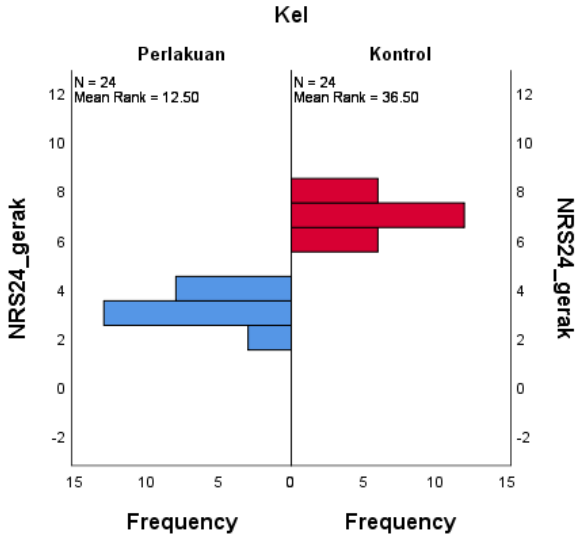


Figure 2. Illustrates The Difference In NRS Scores During Movement Between The Treatment And Control Groups

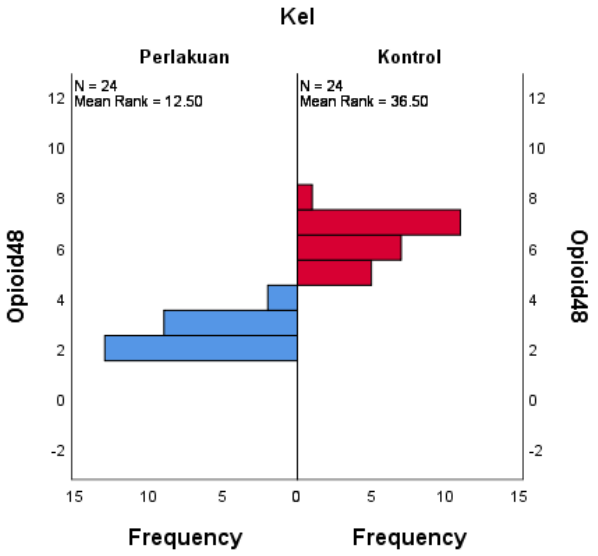
Comparison of Intravenous Opioid Requirement 24-72 Hours Postoperative in Both Groups

This study also compared the opioid requirement within the first 24 hours, 48 hours, and 72 hours postoperatively between the two groups. Data were presented as additional opioid quantities administered during these time intervals. Hence, within the first 24 hours, it indicates the opioid quantity given during that period, while 48 hours represents the total additional opioid after the initial 24 hours, and 72 hours represents the additional opioid given after 48 hours. The comparison data are shown in Table 5.3 below.

Table 3. Intravenous Opioid Requirement 24-72 Hours Postoperative

Characteristic	Group		Normality test[1]	P[2]-value
	Treatment (n=24)	Control (n=24)		
Opioid Quantity				
24 hours	3,75 (±0,79)	7,92 (±1,14)	<0,001	<0,001
48 hours	2,54 (±0,66)	6,33 (±0,87)	<0,001	<0,001
72 hours	0,96 (±0,69)	4,00 (±0,78)	<0,001	<0,001

Figure 3. Difference in Opioid Quantity at 24 Hours Between Groups



Based on table 3, the average opioid quantity during the first 24 hours post-surgery was 3.75 (±0.79) in the treatment group and 7.92 (±1.14) in the control group. Normality testing showed a p-value of less than 0.05 for all data, indicating non-normal distribution. Hence, a non-parametric Mann-Whitney test was conducted. The non-parametric test resulted in a p-value of <0.001, indicating that within the first 24 hours, the opioid consumption in the treatment group was lower than that in the control group (Figure 3.).

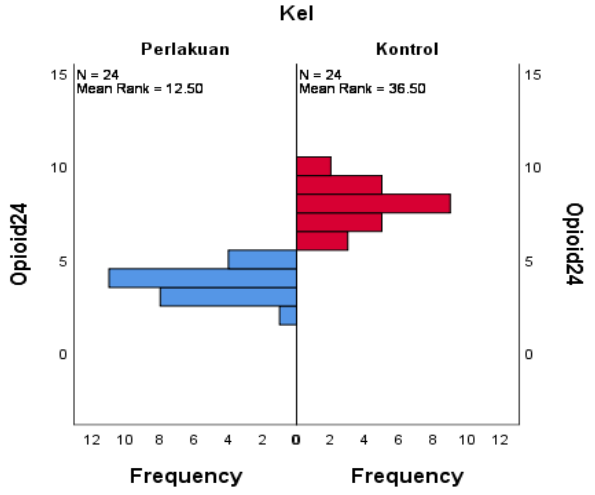


Figure 4. Difference in Opioid Quantity at 48 Hours Between Groups

For the opioid quantity at 48 hours, the treatment group had an average of 2.54 (±0.66), while the control group had 6.33 (±0.87). Similarly, at 72 hours, the treatment group had an average of 0.96 (±0.69), and the control group had 4.00 (±0.78). Normality testing revealed non-normal distribution for the data at 48 and 72 hours, and the Mann-Whitney test yielded significant results, indicating lower opioid consumption at 48 and 72 hours in the treatment group compared to the control group.

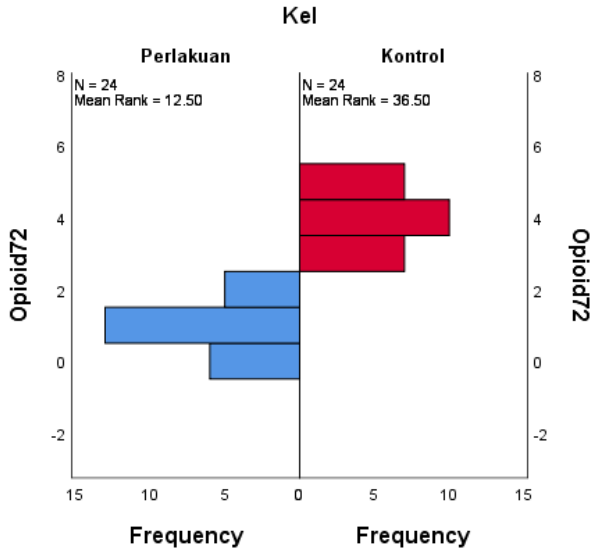


Figure 5. Difference in Opioid Quantity at 72 Hours Between Groups

Comparison of Postoperative Analgesia Duration Between Groups

Table 4 displays the data of median analgesia duration in both groups. The analgesia duration in the treatment group was calculated from the administration of PENG block until the patient in the treatment group pressed the PCA button for the first time, with an average of 428 minutes, whereas in the control group, the average was 169 minutes. Based on normality testing, data in both groups were found to have non-normal distribution (p=0.004), thus the comparison was conducted non-parametrically using the Mann-Whitney test, yielding a p-value of <0.001. From these findings, it can be concluded that the administration of PENG block in patients undergoing THR results in a longer duration of postoperative analgesia compared to those not receiving the PENG block, and this result is statistically significant.

Table 4. Postoperative Analgesia Duration

Characteristic	Group		Normality test[1]	P[2]-value
	Treatment (n=24)	Control (n=24)		
Duration (minutes)	428,33 (±71,67)	169,17 (±52,33)	0,004	<0,001

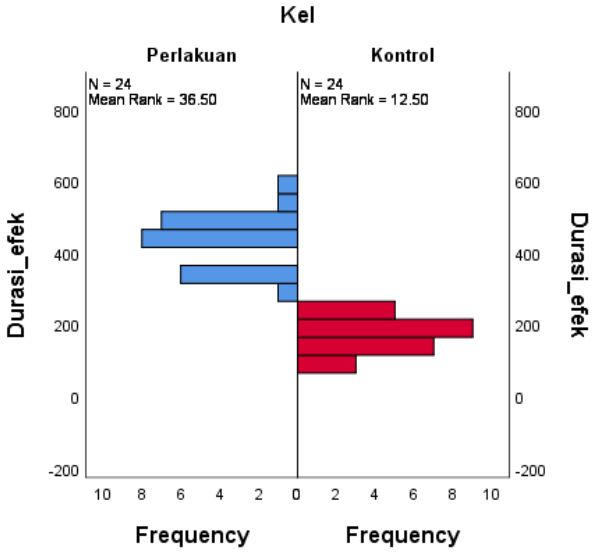


Figure 6. Comparison of Duration of Effect Between Groups

DISCUSSION

One of the most common postoperative side effects, causing discomfort, is pain. Patients undergoing Total Hip Replacement (THR) often experience moderate to severe postoperative pain, putting them at risk of excessive opioid use. This pain is caused by incisions, surgery, which induces tissue trauma or nerve injury such as nerve transection, compression, or stretching during the surgical procedure. The most commonly used analgesia technique for postoperative THR is intravenous opioid administration or neuraxial epidural anesthesia. Intravenous opioids or neuraxial anesthesia have side effects such as nausea, vomiting, pruritus, ileus, constipation, cardiovascular disturbances, respiratory issues, and spinal nerve infections. The PENG block is one of the peripheral nerve blocks that can be used as a component of multimodal analgesia. This block targets the articular branches that innervate the anterior capsule of the hip joint, including the femoral nerve, obturator nerve, and accessory obturator nerve. One advantage of this block is its potential motor-sparing effect, which accelerates patient mobilization. Additionally, with the implementation of this block, it is expected to reduce opioid consumption and mitigate its side effects. This study aims to determine the effectiveness of PENG block analgesia on pain intensity via NRS, opioid consumption within 24, 48, and 72 hours, and postoperative analgesia duration after THR.

Comparison of Pain at 24 hours Using the Numeric Rating Scale

In this study, it was found that the NRS values at 24 hours post-operation in patients receiving PENG block were significantly lower in both resting and movement conditions compared to the control group not receiving PENG block. The PENG block targets the articular branches of the femoral nerve, with additional benefits such as blocking the accessory obturator nerve along with the obturator nerve. The femoral nerve is the longest branch of the lumbar plexus (from the ventral rami of spinal nerves L2-L4), emerging from the lateral border of the psoas muscle, descending between the iliacus and psoas muscles, dividing into two main divisions: anterior and posterior, which provide motor branches (innervation to hip flexors and knee extensors) and sensory branches (innervation to the anteromedial thigh and medial side of the leg and foot). The femoral nerve gives rise to motor branches that are sent to the iliacus before passing under the inguinal ligament (Ben Aziz & Mukhdomi, 2024).

The articular branches of the hip joint originate from complex nerve branching. This explains why the femoral nerve block or fascia iliaca compartment block alone is insufficient for hip joint analgesia. The obturator nerve is formed from the lumbar plexus (anterior divisions of L2, L3, and L4), descends through the fibers of the psoas major, runs posteriorly to the common iliac artery, and laterally along the pelvic wall until it divides into two branches in the obturator canal: anterior and posterior branches. The anterior branch pierces the fascia lata to become the cutaneous branch of the obturator nerve, which innervates the middle skin of the medial thigh (Ben Aziz & Mukhdomi, 2024).

The accessory obturator nerve arises from the third and fourth lumbar nerves (from the ventral rami of L2 to L4), often innervating the hip joint and adductor longus. The accessory obturator nerve is found to innervate the medial capsule, containing sensory fibers (Young & Buvanendran, 2014).

An anatomical study by Short et al. showed that the higher branches of the femoral and obturator nerves (including the accessory obturator nerve) provide innervation to the anterior hip capsule and receive major sensory innervation, while the posterior and inferior capsule lacks sensory fibers. The hip capsule is divided into two parts: anterior and posterior, with most nociceptive fibers located in the anterior part, while the posterior part contains mechanoreceptors (Short et al., 2018).

The anatomical pathways passing through the psoas major fibers and the relationship of the articular branches of these three nerves in the inferomedial acetabulum and the space between the anterior inferior iliac spine and the iliopubic eminence enable it as a potential site for regional analgesia administration. Local anesthesia administration in this space will contribute to the anesthesia of these three nerves and provide sufficient analgesia for hip surgery (Singh & Ahmed, 2020).

A study by Pascarella et al. also found similar findings to this study. In their research, patients undergoing THR received PENG block or no block (control group). The primary outcome measure was the maximum pain score (numeric scale 0–10) measured in the first 48 hours after surgery. The maximum pain score in patients receiving pericapsular nerve block was significantly lower than the control group at all time points, with a median (IQR [range]) of 2.5 (2.0–3.7 [0–7]) vs. 5.5 (5.0–7.0 [2–8]) at 12 hours; 3 (2.0–4.0 [0–7]) vs. 6 (5.0–6.0 [2–8]) at 24 hours; and 2.0 (2.0–4.0 [0–5]) vs. 3.0 (2.0–4.7 [0–6]) at 48 hours; all $p < 0.001$. Additionally, the PENG block group showed a significant reduction in opioid consumption, better hip range of motion, and shorter ambulation time (Pascarella et al., 2021).

A case report presented by Fujino et al. also found similar results. In patients undergoing THR who received PENG block, low NRS scores were observed at 2, 12, 24, and 48 hours post-operation, indicating that the treatment was effective in managing postoperative pain. Their study concluded that PENG block is effective for postoperative pain management in patients undergoing THR (Fujino et al., 2021).

Comparison of Intravenous Opioid Consumption at 24, 48, and 72 hours Postoperatively

The intravenous opioid consumption in this study was found to be lower in the PENG block group compared to the non-block group at 24 hours, 48 hours, and 72 hours after the surgical procedure, and this value was statistically significant. Identifying the ideal peripheral nerve block for THR has proven to be challenging due to the complex hip innervation and the desire to avoid postoperative muscle weakness. A study by Kukreja et al. found that subjects receiving PENG block for THR had significantly better recovery quality and reduced opioid use at 24 hours and 48 hours post-operation compared to subjects not receiving PENG block (Kukreja et al., 2023).

In this study, the PENG block was administered as a single shot, thus providing limited analgesic effect. Rebound pain has been reported in some cases after single-shot peripheral

nerve blocks (Nobre et al., 2020). In patients here, we administered paracetamol and ketorolac to prevent pain when the analgesic effect of the block had worn off or to prevent rebound pain, in addition to opioid administration, similar to the study conducted by (Domagalska et al., 2023). Paracetamol and nonsteroidal anti-inflammatory drugs (ketorolac) were also administered in the control group, expected to serve as multimodal analgesia working synergistically through different mechanisms and minimizing the dose and side effects of single opioids. Here, the researchers speculate that in the control group, the average opioid consumption is not too high due to the addition of these medications. Although statistically, the average opioid consumption in the treatment group is still much lower. This is supported by previous research by (Robinson et al., 2021), which found that adding paracetamol and nonsteroidal anti-inflammatory drugs can reduce postoperative opioid consumption.

The PENG block is a peripheral nerve block technique that can be used as an alternative analgesia for postoperative hip surgery, which can be used in combination with other regional anesthesia techniques for effectively targeting the anterior hip capsule by blocking the articular branches of the femoral nerve and accessory obturator nerve. The PENG block does not cause postoperative motor block, thus improving and speeding up mobilization (Fujino et al., 2021). The use of multimodal analgesia combined with regional analgesia, including nerve blocks and periarticular infiltration techniques, is associated with reduced postoperative opioid use and reduced morbidity and hospital length of stay (Ben Aziz & Mukhdomi, 2024).

In a retrospective review comparing the analgesic benefits of adding PENG block after THR, the authors (Kiran Mysore MD et al.) identified 123 patients who met the inclusion criteria; 47 received and 76 did not receive PENG block. They found that PENG block was associated with reduced 24-hour hydromorphone consumption (Mysore et al., 2020).

Ueshima and Otake documented their clinical experience using the PENG technique in four patients for perioperative pain management after hip dislocation reduction and hip replacement; they concluded that based on their successful experience, the PENG block technique can encompass the femoral and obturator nerves and can be used as an effective method of hip surgery analgesia (Ueshima & Otake, 2019).

Comparison of Postoperative Analgesia Duration

In the assessed duration of effect in both groups, it was found that the group receiving PENG block had a longer pain-free effect duration compared to the group not receiving PENG block. Adequate postoperative pain management for THR is crucial for early rehabilitation and patient satisfaction. The PENG block has been successfully used in multimodal pain management for hip fracture and postoperative pain management after THR (Pascarella et al., 2021).

The research conducted by Domagalska supports the findings in this study. In their study, the total opioid consumption, expressed in intravenous equivalents, was lower in the PENG group at all time points: 2.3 vs. 8.4 at 24 hours, 0.5 vs. 2.5 at 48 hours, and 0 vs. 0.3 at 72 hours, all $p < 0.0001$. Additionally, the mean time to first opioid use was 5 hours shorter in the control group ($p < 0.0001$), indicating that the PENG group provided a longer duration of effect (Domagalska et al., 2023).

The PENG block can be used alone as a primary analgesic or in conjunction with other forms of anesthesia during surgery or the perioperative period. For lateral surgical incisions, the lateral femoral cutaneous nerve block can be given to provide additional protection (Berlioz & Bojaxhi, 2020; Højer Karlsen et al., 2015).

No complications such as LAST arrhythmia, allergic reactions, nausea, and vomiting were observed during the intraoperative or postoperative period in any patient. No block-related complications or side effects were observed postoperatively. The use of ultrasound in

administering the PENG block enhances safety and accuracy, thereby reducing side effects and complications in the treatment group.

CONCLUSION

The 24-hour postoperative pain scale assessed with NRS in Total Hip Replacement patients receiving Pericapsular Nerve Group (PENG) block with subarachnoid regional anesthesia was significantly lower compared to the control group. The intravenous opioid requirement at 24 hours, 48 hours, and 72 hours in Total Hip Replacement patients receiving Pericapsular Nerve Group (PENG) block with subarachnoid regional anesthesia was significantly lower compared to the control group. The postoperative analgesia duration measured from the time the patient first pressed the PCA button in Total Hip Replacement patients receiving Pericapsular Nerve Group (PENG) block with subarachnoid regional anesthesia was significantly longer compared to the control group.

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