ORIGINAL ARTICLE

Comparative Study of Continuous Epidural Analgesia, Femoral Nerve Block and Patient Controlled Analgesia for Postoperative Analgesia Following Knee Surgery

Ahmed M. A. Elsayed, Abdalla M. A. Abdalla, Mahmoud I. M. Elfowy *

Department of Anesthesiology, Intensive Care and Pain Management, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***Postoperative pain is insufficiently managed, despite significant advancements in the understanding of pain mechanisms and therapy.***

Aim: ***To compare the effect of continuous epidural analgesia, femoral nerve block, and patient-controlled analgesia for postoperative analgesia following a knee operation.***

Patients and methods: ***This randomized controlled single -blind investigation has been performed on 90 cases who were selected from the attendee of out-patient Anesthesiology, Intensive Care and Pain Management Clinics of Al-Azhar University Hospitals from November 2023 to august 2024.***

Results: ***An insignificant distinction in VAS levels has been observed among the three groups at most time points; however, Group E had significantly reduced VAS scores than Group F and Group P at 6 and 12 hours, respectively ($p<0.05$). Similarly, while mean arterial pressure showed insignificant variation among the groups at baseline, 0h, 1h, 24h, 36h, and 48h, Group E had significantly reduced values compared to Group F and Group P at 6 and 12 hours ($p<0.05$). Postoperative nausea and vomiting (PONV) and pruritus were comparable among groups, and no cases of hypoventilation were observed ($p>0.05$). Notably, patient satisfaction was significantly greater in Group E than in the other groups ($p=0.009$).***

Conclusion: ***Continuous epidural analgesia offers superior pain relief and hemodynamics than continuous femoral nerve block and patient-controlled analgesia following knee surgery. It also reduces total opioid consumption, improves patient satisfaction, and is less invasive than a continuous femoral nerve block.***

Keywords: Patient Controlled Analgesia; Femoral Nerve Block; Continuous Epidural Analgesia; Knee Surgery

1. Introduction

Postoperative pain is insufficiently managed, despite significant advancements in the understanding of pain mechanisms and therapy. The presence of symptoms following the operation, such as pain, significantly exacerbates patient dissatisfaction with their anesthesia and operative experience, in addition to the physiological ill impacts. It has been demonstrated that insufficiently managed postoperative pain can result in chronic pain.[1]

Major knee surgeries, including total knee arthroplasty (TKA), total knee replacement (TKR), and anterior cruciate ligament reconstruction, are related to moderate to severe postoperative pain.[2] Lower limb operations can benefit from regional anesthetic methods that decrease neuroendocrine stress responses, central nervous system sensitization, and muscle spasms triggered by painful stimuli.[3]

Epidural analgesia has become an essential element in the multimodal management of postoperative pain after orthopedic procedures, aimed at enhancing pain relief, facilitating early movement, and increasing adherence to physiotherapy, thereby improving overall results. Cases undergoing epidural analgesia can experience autonomic abnormalities, unintentional motor blockage, urine retention, and pruritus (when opioids are used as adjuvants) as adverse effects, along with a higher possibility of neurological complications associated with anticoagulant medication.[4]

Accepted 15 April 2025.
Available online 30 June 2025

* Corresponding author at: Anesthesiology, Intensive Care and Pain Management, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: islam.orth1592@gmail.com (M. I. M. Elfowy).

https://doi.org/10.21608/aimj.2025.446601

The patient-controlled analgesia (PCA) technique is a proven and often utilized technique for the self-administration of analgesic drug-specified doses to alleviate acute pain. Patient-controlled analgesia may decrease the prevalence of gaps in analgesic delivery, ensuring more consistent analgesia and eliminating painful waiting durations between the request and administration of treatment. Patients who utilized patient-controlled analgesia exhibited less acute pain in addition to a shorter duration of hospitalization. Patient-controlled analgesia became a standard of care in acute pain management following operations within hospital environments, offering superior pain control and enhanced patient satisfaction.[5]

This investigation aimed to compare the effectiveness of continuous epidural analgesia, femoral nerve block, and patient-controlled analgesia for postoperative analgesia following a knee operation.

2. Patients and methods

This randomized controlled single -blind investigation has been carried out on 90 cases who were selected from the attendees of out-patient Anesthesiology, Intensive Care, and Pain Management Clinics of Al-Azhar University Hospitals from November 2023 to August 2024

Inclusion criteria: Cases aged between 40 and 70 years, comprising both males and females. Eligibility criteria required participants to have an American Society of Anesthesiologists (ASA) classification of one to three. All cases were undergoing unilateral knee surgery, involving total knee replacement, anterior cruciate ligament (ACL) injury repair, and patella fracture fixation.

Exclusion criteria: Patient refusal, major spinal deformities, a history of local anesthetic allergy, skin infection at the injection site, pre-existing myopathic or neuropathic conditions, and recognized cognitive impairments. Cases receiving long-acting opioids throughout the preoperative duration, those with sleep apnea, chronic renal failure, or an inability to understand the concept behind patient-controlled analgesia (PCA) were also excluded. Additionally, individuals with contraindications to femoral nerve block (FNB) weren't included in the study.

Sample size

This investigation, based on the research conducted by Kalad et al. 6, utilized Epi Info STATCAL to determine the required sample size. The calculation was performed with a 95% confidence level, a test power of 90%, an exposure-to-non-exposure ratio of 1, and an outcome occurrence of 29% in the unexposed group. The outcome in the exposed group was estimated at 60%. According to these variables, the minimum required sample size was established to be 90 cases, which were categorized into three groups for the study afterward.

Randomization and blinding

Cases have been categorized into three groups (number = thirty cases per group) in a randomized fashion utilizing a computer-generated list of random permutations. Using opaque sealed envelopes: Group E (Number = thirty): Throughout the 1st 48h following surgery, analgesia was delivered directly postoperatively and was continued in the ward by using continuous epidural analgesia. Group F (Number =thirty): US-guided continuous femoral nerve block and Group P (Number =thirty): IV PCA with nalbuphine (concentration 0.2 mg/mL, rate of 1mg/hr, with 1mg on-demand dose, lockout 20 min). The study was single-blinded, in which the cases were blinded to the technique.

Methods

All patients were subjected to the following:

Preoperative assessment involved a comprehensive history of the patient, including demographic data, medical and surgical history, and current complaints. A clinical examination was conducted, including vital signs, and routine laboratory tests were performed. Cases were also informed about their pain score using the Visual Analog Scale. A wide-bore cannula was inserted, and intravenous fluid administration was initiated with 500 ml of saline.

Technique

The epidural catheter has been inserted at the L4-L5 intervertebral level, followed by spinal anesthesia in the sitting position. The femoral catheter has been inserted utilizing ultrasound guidance while the case was in the supine posture, and spinal anesthesia has been administered in the sitting position. Intraoperative patient management involved following up for complications involving bradycardia, desaturation, hypotension, nausea, vomiting, and other adverse effects. Predefined interventions were used to manage these issues. In Group E (epidural analgesia), 30 cases received an epidural catheter before spinal anesthesia, with local anesthetic administered postoperatively. The catheter has been inserted at L3-L4 or L4-L5 utilizing an 18-gauge, 8.89 cm needle, confirmed by the loss of resistance (LOR) method. A continuous infusion of 0.125 percent bupivacaine with fentanyl at two micrograms per milliliter has been maintained at a rate of five milliliters per hour for a duration of forty-eight hours, with catheter removal on postoperative day two. In Group F (femoral nerve block), 30 cases underwent ultrasound-guided femoral nerve block catheter insertion after spinal anesthesia. The femoral nerve was identified laterally or posterolaterally to the femoral artery at the femoral triangle. An 18-gauge,

3.5-inch echogenic epidural set needle has been utilized, and a continuous infusion of 0.125 percent bupivacaine with fentanyl two micrograms per milliliter has been maintained for 48 hours. In Group P (PCA), 30 cases had a peripheral vein cannulated before spinal anesthesia, and a PCA device was connected postoperatively. Cases received a 275 ml PCA device containing 60 mg nalbuphine, delivering a basal infusion of 1 mg/hr. Cases were encouraged to self-administer boluses as needed for pain control.

Postoperative assessment

Postoperative hemodynamic monitoring was conducted, recording baseline MBP, HR, side effects, and analgesic dose requirements. The patient received 1,000 mg of intravenous paracetamol every 8 hours postoperatively. Postoperative pain has been evaluated utilizing a visual analogue scale (VAS), with VAS scores monitored at zero, one, six, twelve, twenty-four, thirty-six, and forty-eight hours. Cases with visual analogue scale scores over three were managed with a five-milliliter top-up dose, and 30 30-milligram rescue dose of ketorolac has been given for persistent pain relief.

Satisfaction score: The Likert scale is a survey rating system used to assess patient satisfaction by asking a single question. Pain sensitivity, hemodynamics, satisfaction, analgesic requirements, and complications were assessed in three groups. Pain sensitivity was measured using static and dynamic pain, and pain control has been evaluated using the Visual Analog Scale. Hemodynamic parameters were monitored, and patient satisfaction has been measured utilizing a rating scale. Complications like adverse reactions, pruritus, nausea, vomiting, or hypoventilation were documented.

Statistical analysis

Statistical analysis has been carried out utilizing SPSS v27 (IBM©, Chicago, Illinois, United States of America), the Shapiro-Wilks test, and histograms assessed normality of data distribution. Quantitative parametric data have been expressed as mean and standard deviation (SD) and analyzed utilizing ANOVA (F) with a post hoc Tukey test. Quantitative non-parametric data has been expressed as median and interquartile range (IQR) and analyzed utilizing the Kruskal-Wallis test, with the Mann-Whitney test utilized for group comparisons. Qualitative parameters were presented as percentages (%) and frequency and analyzed utilizing the Chi-square test. A two-tailed P-value less than 0.05 has been regarded as statistically significant.

3. Results

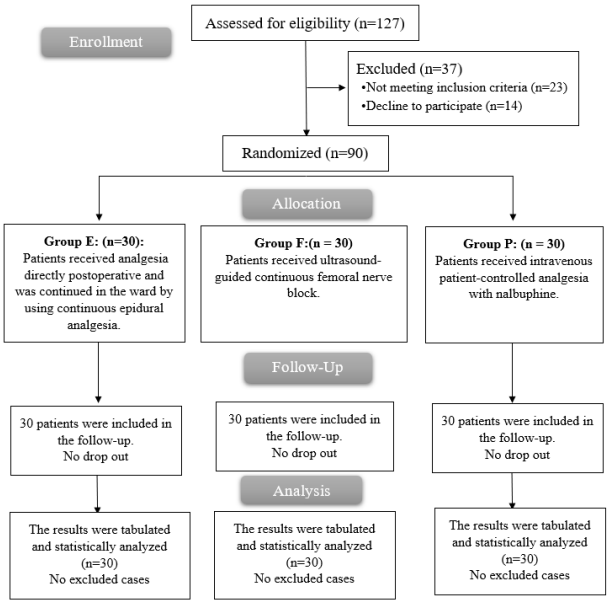

Figure 1. CONSORT flowchart of the enrolled cases

Sex, age, height, weight, body mass index, American Society of Anesthesiologists physical status and duration of surgery were insignificantly distinct between the three groups p value less than 0.05. (Table 1)

Table 1. Baseline characteristics and surgery duration of investigated groups

		GROUP E (NUMBER=30)	GROUP F (NUMBER=30)	GROUP P (NUMBER=30)	P VALUE
AGE (YEARS)	Mean ± SD	54.3 ± 6.52	53.9 ± 8.6	56.8 ± 7.66	0.290
	Range	44 - 67	40 - 70	42 - 69	
SEX	Male	17 (56.67%)	16 (53.33%)	19 (63.33%)	0.727
	Female	13 (43.33%)	14 (46.67%)	11 (36.67%)	
WEIGHT (KG)	Mean ± SD	78.8 ± 8.13	80.9 ± 8.11	76.8 ±11.05	0.237
	Range	65 - 92	68 - 93	61 - 95	
HEIGHT (CM)	Mean ± SD	167.8 ± 7.13	166.9 ± 5.11	168.6 ± 5.89	0.560
	Range	154 - 180	161 - 179	159 - 178	
BMI (KG/M^2)	Mean ± SD	28.2 ± 4.14	29.2 ± 3.82	27.1 ± 4.43	0.172
	Range	21.3 - 37.1	22.8 - 35.9	20.5 - 34.8	
ASA PHYSICAL STATUS	I	13 (43.33%)	11 (36.67%)	14 (46.67%)	0.877
	II	11 (36.67%)	10 (33.33%)	9 (30%)	
	III	6 (20%)	9 (30%)	7 (23.33%)	
SURGERY DURATION (MIN)	Mean ± SD	124.7 ±11.14	126.8 ± 8.35	128.6 ±12.03	0.355
	Range	110 - 140	115 - 140	110 - 154	

Time of 1st rescue analgesia has been significantly postponed in (F and E groups) than group P and has been significantly postponed in group E than group F (P-value less than 0.001). Total ketorolac consumption has been significantly reduced in (F and E groups) than group P and has been significantly reduced in group E compared to group F (P-value less than 0.05). (Table 2)

Table 2. Time of 1st rescue analgesia and total ketorolac consumption of investigated groups

		GROUP E (NUMBER=30)	GROUP F (NUMBER=30)	GROUP P (NUMBER=30)	P VALUE	POST HOC
TIME OF 1ST RESCUE ANALGESIA (H)	Mean ± SD	11.1 ± 0.78	7.1 ± 0.73	5.1 ± 0.76	<0.001*	P1 less than 0.001* P2 less than 0.001* P3 less than 0.001*
	Range	10 - 12	6 - 8	4 - 6		
TOTAL KETOROLAC CONSUMPTION (MG)	Mean ± SD	83 ± 12.91	98 ± 13.49	113±23.22	<0.001*	P1 equals 0.003* P2 less than 0.001* P3 equals 0.003*
	Range	60 - 90	90 - 120	90 - 150		

*: Significant as P value not more than 0.05, P1: P value among E and F groups, P2: P value among E and P groups, P3: P value among F and P groups.

A significant distinction in VAS levels has been observed among the three groups at different time points. Nevertheless, group E had significantly reduced VAS compared to group F and group P at 6 hours and 12 hours, correspondingly p value less than 0.05. (Table 3)

Table (3): VAS of investigated groups

	GROUP E (NUMBER=30)	GROUP F (NUMBER=30)	GROUP P (NUMBER=30)	P VALUE	POST HOC
0H	1(0 - 1)	1(0 - 1)	1(0 - 1)	0.486	
1H	1(1 - 2)	1(1 - 2)	2(1 - 2)	0.175	
6H	1(1 - 2)	2(1 - 3)	3(2 - 5)	<0.001*	P1 equals 0.029* P2 less than 0.001* P3 equals 0.038*
12H	2.5(1 - 4)	3(2.25 - 5)	4(3 - 5)	0.008*	P1 equals 0.038* P2 equals 0.002* P3 equals 0.330
24H	4(3 - 4)	4(3 - 5)	4(3 - 5)	0.390	
36H	4(2.25 - 4)	4(3 - 4)	4(3 - 5)	0.868	
48H	4(3 - 5)	4(3 - 5)	4(4 - 5)	0.243	

Data presented as median (IQR)

An insignificant distinction in mean arterial pressure has been observed among the three groups at baseline, 0h, 1h, 24h, 36h, and 48h p-value more than 0.05. However, group E had significantly reduced mean arterial pressure than group F and group P at 6h, 6h, and 12h, correspondingly pvalue more than 0.05. (Table 4)

Table 4. Mean arterial pressure of investigated groups

	GROUP E (NUMBER=30)	GROUP F (NUMBER=30)	GROUP P (NUMBER=30)	P VALUE	POST HOC
BASELINE	92.37±12.98	94.33±11.72	96.5±12.42	0.437	
0H	88.4±13.04	91.57±11.94	93.4±12.58	0.299	
1H	90.67±13.09	94.57±11.86	96.97±12.64	0.151	
6H	90.8±13.28	99.43±11.59	107.93±15.47	<0.001*	P1 equals 0.041* P2 less than 0.001* P3 equals 0.045*
12H	96.9±15.55	106.2±13.18	109.43±15.48	0.004*	P1 equals 0.044* P2 equals 0.004* P3 equals 0.675
24H	103.03±17.75	106.97±16.57	108.57±15.58	0.420	
36H	102.13±14.81	106.5±14.28	108.37±14.22	0.235	
48H	101.6±15.73	105.9±15.74	110.63±14.89	0.083	

Data presented as mean ± SD

PONV and pruritis were insignificantly distinct between the three groups. Hypoventilation didn't happen in any cases in the three groups p value more than 0.05. (Table 5)

Table 5. Complications of investigated groups

	GROUP E (NUMBER=30)	GROUP F (NUMBER=30)	GROUP P (NUMBER=30)	P VALUE
HYPOVENTILATION	0 (0%)	0 (0%)	0 (0%)	---
PONV	7 (23.33%)	4 (13.33%)	5 (16.67%)	0.587
PRURITIS	3 (10%)	1 (3.33%)	2 (6.67%)	0.585

Data presented as frequency (%)

Patient satisfaction was significantly higher in group E than (F and P groups) (P value equals 0.009). (Table 6)

Table 6. Patient satisfaction of investigated groups

		GROUP E (NUMBER=30)	GROUP F (NUMBER=30)	GROUP P (NUMBER=30)	P VALUE
PATIENT SATISFACTION	Very satisfied	18 (60%)	10 (33.33%)	6 (20%)	0.009*
	Satisfied	7 (23.33%)	11 (36.67%)	5 (16.67%)	
	Neutral	4 (13.33%)	4 (13.33%)	10 (33.33%)	
	Dissatisfied	1 (3.33%)	3 (10%)	4 (13.33%)	
	Very dissatisfied	0 (0%)	2 (6.67%)	5 (16.67%)	

4. Discussion

Postoperative pain management after a knee operation is a significant issue, since numerous cases encounter intolerable pain. Severe pain encountered in the early duration following operation hinders fast rehabilitation by obstructing the patient's ability to engage in activities and can elevate the possibility of postoperative complications, like thromboembolic disease or nosocomial infections.[7,8]

In this present study, time of 1st rescue analgesia has been significantly postponed in (E and F groups) compared to group P and has been

significantly postponed in group E compared to group F. Total ketorolac utilization has been significantly reduced in (E and F groups) compared to group P and has been significantly reduced in group E compared to group F.

Agreeing with our findings, Kalad et al.[6] performed a prospective randomized controlled investigation on sixty cases aged older than 40 years with ASA one to three who were scheduled to undergo unilateral TKR. These cases have been categorized into three equivalent groups: group A administered continuous epidural analgesia, Group B administered CFNB, and group C administered continuous adductor canal block (ACB). They found that postoperative total opioid utilization has been significantly reduced in continuous epidural group compared to CFNB group.

In current study, VAS has been insignificantly distinct at 0h, 1h, 24h, 36h and 48h between the three groups. VAS was significantly reduced in group E than (F and P groups) and has been significantly reduced in group F than group P at 6h. VAS has been significantly reduced in group E than (F and P groups) and was insignificantly distinct among F and P groups at twelve hours.

The knee innervation is complex, involving contributions from sacral and lumbar plexuses. It adheres to Hilton's law, which states that nerves that supply muscles around a joint also supply the joint itself. The obturator, tibial, femoral, and peroneal nerves all contribute to the knee joint nerve supply. Targeting solely the femoral nerve limits the achievement of perfect analgesia, as contributions from other nerves remain neglected. This may clarify the reduced pain scores observed in the continuous epidural analgesia group compared to the CFNB group.[9,10]

Comparable with our outcomes, Kalad et al.[6] found that visual analogue scale has been significantly reduced in continuous epidural group than CFNB group at different time intervals.

In the present study, mean arterial pressure and heart rate were insignificantly different at baseline, 0h, 1h, 24h, 36h, and 48h among the three groups. Mean arterial pressure and heart rate have been significantly reduced in group E compared to (P and F groups), and have been significantly reduced in group F compared to group P at 6h. Mean arterial pressure and heart rate have been significantly reduced in group E compared to (P and F groups), and were insignificantly distinct among P and F groups at twelve hours. SpO2 was insignificantly distinct among the three groups.

Supporting our results, Kalad et al.[6] found that mean arterial pressure has been significantly reduced in continuous epidural group than CFNB group at different time intervals.

Comparable with our outcomes, Lu et al.[11] carried out research to compare femoral nerve block, epidural block, and IV-PCA regarding pain control following surgery and rehabilitation course in cases that underwent TKA. They found that no distinction in mean arterial pressure and heart rate has been observed over the 1st 72 hours post-anesthesia recovery across all three groups. These distinctions might be attributed to the different types of procedures and local anesthetics used in both studies as they used for IV-PCA group, (fentanyl ten micrograms per kilogram), NSAIDs and others like tramadol in a dose of two milliliters per hour, for FNB group, single-injection femoral nerve blocks (twenty milliliters of 0.375 percent ropivacaine) and for epidural group, (three milliliters of 1.5 percent lidocaine with epinephrine). Then a bolus dose of 0.25 percent bupivacaine.

In the current study, PONV and pruritus were insignificantly distinct between the three groups. Hypoventilation didn't occur in any cases in the three groups.

In consistence with our outcomes, Ng et al.[12] carried out a research on 60 cases aged 51 to 84 years with American Society of Anesthesiologists one to three undergoing TKA. These cases have been categorized into two equivalent groups: CFNB group and IV-PCA group. they reported that PONV and pruritis were insignificantly distinct between both groups.

Unlike our results, Sundarathiti et al.[13] found that pruritus and PONV were significantly higher in the continuous epidural group compared to the CFNB group. This might be attributed to the different population, sample size, and the different types of local anesthetics utilized in both studies, as they utilized for cases in the continuous epidural group, continuous infusion of 0.125 percent levobupivacaine with morphine 0.0125 milligrams per milliliter (four milliliters per hour), and for cases in CFNB group, 0.125 percent levobupivacaine (eight milliliters per hour).

In the current investigation, patient satisfaction was significantly greater in group E compared to the P and F groups.

In consistence with our outcomes, Ng et al. 12 showed that patient satisfaction was insignificantly distinct among both CFNB group and IV-PCA group.

4. Conclusion

Continuous epidural analgesia offers superior pain relief and hemodynamics compared to continuous femoral nerve block and patient-controlled analgesia after a knee operation. It also reduces total opioid consumption, improves patient satisfaction, and is less invasive than a

continuous femoral nerve block.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

Funding

No Funds : Yes

Conflicts of interest

There are no conflicts of interest.

References

1. Gan TJ. Poorly controlled postoperative pain: prevalence, consequences, and prevention. J Pain Res. 2017; 10:2287-2298. Published 2017 Sep 25. doi:10.2147/JPR.S144066
2. Marques FDS, Barbosa PHB, Alves PR. Anterior Knee Pain After Anterior Cruciate Ligament Reconstruction. Orthop J Sports Med. 2020;8(10):2325967120961082. Published 2020 Oct 27. doi:10.1177/2325967120961082
3. Rodriguez-Patarroyo FA, Cuello N, Molloy R, Krebs V, Turan A, Piuzzi NS. A guide to regional analgesia for Total Knee Arthroplasty. EFORT Open Rev. 2021;6(12):1181-1192. Published 2021 Dec 10. doi:10.1302/2058-5241.6.210045
4. Goel S, Deshpande SV, Jadawala VH, Suneja A, Singh R. A Comprehensive Review of Postoperative Analgesics Used in Orthopedic Practice. Cureus. 2023;15(11):e48750. Published 2023 Nov 13. doi:10.7759/cureus.48750
5. Wirz S, Seidensticker S, Shtrichman R. Patient-Controlled Analgesia (PCA): Intravenous Administration (IV-PCA) versus Oral Administration (Oral-PCA) by Using a Novel Device (PCoA® Acute) for Hospitalized Patients with Acute Postoperative Pain-A Comparative Retrospective Study. Pain Res Manag. 2021;2021:2542010. Published 2021 May 4. doi:10.1155/2021/2542010
6. Kalad RN, Ali HO, Thabet WR, Elsotouhy AM, Sharaf AG. A comparative study between continuous epidural analgesia, ultrasound guided continuous femoral nerve block (CFNB), and ultrasound guided continuous adductor canal block (ACB) for post-operative pain management after total knee replacement (TKR). Ain-Shams Journal of Anesthesiology. 2023 Mar 30;15(1). doi:10.1186/s42077-023-00311-z
7. Lavand'homme PM, Kehlet H, Rawal N, Joshi GP; PROSPECT Working Group of the European Society of Regional Anaesthesia and Pain Therapy (ESRA). Pain management after total knee arthroplasty: PROcedure SPEcific Postoperative Pain ManagemenT recommendations. Eur J Anaesthesiol. 2022;39(9):743-757. doi:10.1097/EJA.0000000000001691
8. Koga M, Maeda A, Morioka S. Description of pain associated with persistent postoperative pain after total knee arthroplasty. Sci Rep. 2024;14(1):15217. Published 2024 Jul 2. doi:10.1038/s41598-024-66122-w
9. Hébert-Blouin MN, Tubbs RS, Carmichael SW, Spinner RJ. Hilton's law revisited. Clin Anat. 2014;27(4):548-555. doi:10.1002/ca.22348
10. Hasan MN, Saleem SA, Rehman Rao SU, Wasim MH, Durrani NA, Naqvi SA. Comparison of the Efficacy of Continuous Femoral Nerve Block with Epidural Analgesia for Postoperative Pain Relief After Unilateral Total Knee Replacement. Cureus. 2022;14(4): e24524. Published 2022 Apr 27. doi:10.7759/cureus.24524
11. Lu Y, Huang HM, Yan J, Jiang H. Comparison of postoperative femoral nerve block, epidural block and intravenous patient-controlled analgesia in pain control and postoperative rehabilitation after total knee arthroplasty. Int J Clin Exp Med. 2017 Jan 1;10(4):6680-7. www.ijcem.com /ISSN:1940-5901/IJCEM0045154
12. Ng FY, Chiu KY, Yan CH, Ng KF. Continuous femoral nerve block versus patient-controlled analgesia following total knee arthroplasty. J Orthop Surg (Hong Kong). 2012;20(1):23-26. doi:10.1177/230949901202000105
13. Sundarathiti P, Ruananukul N, Channum T. A comparison of continuous femoral nerve block (CFNB) and continuous epidural infusion (CEI) in postoperative analgesia and knee rehabilitation after total knee arthroplasty (TKA). J Med Assoc Thai. 2009;92(3):328-334.