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SUPERIOR ANALGESIA AND ENHANCED RECOVERY WITH ADDUCTOR CANAL BLOCK AS COMPARED TO OTHER PAIN MODALITIES IN TOTAL KNEE ARTHROPLASTY

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ABSTRACT Total knee arthroplasty (TKA) is a prevalent orthopedic procedure aimed at alleviating pain and restoring function in patients with advanced knee joint pathology. Effective postoperative pain management is crucial for facilitating early mobilization, reducing hospital stays, and improving overall patient outcomes. This study provides a comparative analysis of three analgesic techniques—adductor canal block (ACB), femoral nerve block (FNB), and epidural analgesia (EA)—evaluating their efficacy in postoperative pain control, opioid consumption, and functional recovery in TKA patients.

KEYWORDS : total knee arthroplasty, adductor canal block, femoral nerve block, epidural analgesia, numerical rating scale, morphine

INTRODUCTION

Major knee operations such as total knee arthroplasty and anterior cruciate ligament (ACL) reconstruction are frequently accompanied by moderate to severe postoperative pain [1]. These lower limb procedures are well-suited to regional anesthesia techniques, which help mitigate the neuroendocrine stress response, reduce central nervous system sensitization, and minimize muscle spasms that result from noxious stimuli [2].

Total knee arthroplasty (TKA), in particular, is known to cause significant postoperative pain, which can lead to elevated blood pressure, rapid heart rate, increased oxygen consumption, and heightened cardiac strain. This pain response enhances sympathetic nervous system activity, stimulates the release of catabolic hormones, and suppresses immune function [3].

Despite advances in understanding pain mechanisms and improved pain management strategies, postoperative pain control remains inadequate in many cases [4]. Beyond the physiological impacts, persistent postoperative discomfort can negatively influence a patient's perception of their surgical and anesthetic experience, often leading to dissatisfaction [5]. There is strong evidence that poorly managed acute postoperative pain can progress to chronic pain [6].

Epidural analgesia has become an important part of the multimodal pain management strategy used after orthopedic procedures. It plays a vital role in achieving adequate pain control, facilitating early mobilization, and enhancing participation in physiotherapy, all of which contribute to better overall surgical outcomes [7].

Peripheral nerve blocks are also known to offer highly effective postoperative analgesia following knee surgery. Studies indicate that nerve blocks provide pain relief comparable to intravenous patient-controlled analgesia, but with fewer opioid-related side effects, and they often cause less hypotension compared to some epidural techniques. However, femoral nerve blocks (FNB) may weaken the quadriceps muscle, increasing the risk of falls and potentially delaying early postoperative rehabilitation, which can affect patient satisfaction. Hence, an ideal nerve block should offer effective analgesia while preserving muscle strength [8].

The adductor canal block (ACB) is a relatively recent technique developed for pain relief following TKA. It involves injecting local anesthetic into the adductor canal, which is readily identifiable in the mid-thigh region under ultrasound guidance, allowing for consistent and successful application. Anatomical studies have shown that the adductor canal houses multiple sensory nerves—such as the saphenous and medial femoral cutaneous nerves—but only one motor nerve, the nerve to the vastus medialis, minimizing the risk of motor impairment [9].

The objective of this study was to evaluate and compare the effectiveness of continuous adductor canal block, femoral nerve block, and epidural analgesia for managing postoperative pain following total knee replacement surgery.

MATERIALS AND METHODS

A prospective, randomized controlled study was conducted involving 90 patients undergoing unilateral TKA. Patients were randomized into three equal groups of 30 patients each:

- Group A (ACB): Received ultrasound-guided adductor canal block with 20 mL of 0.5% ropivacaine.
- Group B (FNB): Received ultrasound-guided femoral nerve block with 20 mL of 0.5% ropivacaine.
- Group C (EA): Received epidural analgesia with 10 mL of 0.5% ropivacaine, followed by continuous infusion at 5 mL/hour.

Pain intensity was assessed using the Numerical Rating Scale (NRS) at 6, 12, 24, and 48 hours postoperatively. Total morphine consumption, time to first analgesic request, quadriceps muscle strength, and incidence of side effects were also recorded.

RESULTS

Pain Scores:

Group A exhibited significantly lower NRS scores at all time points compared to Groups B and C as shown in Table 1. At 6 hours postoperatively, the mean NRS scores were:

- Group A: 2.5 ±0.5
- Group B: 3.8 ±0.6
- Group C: 4.2 ±0.7

This trend persisted at 12, 24, and 48 hours, indicating superior analgesic efficacy of ACB.

Table 1 : Comparative NRS Pain Scores Post-TKA

Time Postoperative	Adductor Canal Block (ACB)	Femoral Nerve Block (FNB)	Epidural Analgesia (EA)
6 hours	2.5 ± 0.5	3.8 ± 0.6	4.2 ± 0.7
12 hours	2.8 ± 0.4	4.0 ± 0.5	4.5 ± 0.6
24 hours	2.6 ± 0.5	3.9 ± 0.6	4.3 ± 0.7
48 hours	2.4 ± 0.4	3.7 ± 0.5	4.1 ± 0.6

Opioid Consumption:

Total morphine consumption over 48 hours was lowest in Group A (12 ±3 mg), followed by Group B (18 ±4 mg) and Group C (22 ±5 mg) as shown in Table 2. The time to first analgesic request was longest in Group A (8 ±1 hours), indicating prolonged analgesia.

Table 2 : Comparative Total Morphine Consumption And Time To First Analgesia Request

Analgesic Technique	Total Morphine Consumption over 48 Hours (Mean ± SD)	Time to First Analgesic Request (Mean ± SD)
Adductor Canal Block (ACB)	12 ± 3 mg	8 ± 1 hours
Femoral Nerve Block (FNB)	18 ± 4 mg	5 ± 1 hours
Epidural Analgesia (EA)	22 ± 5 mg	4 ± 1 hours

Quadriceps Strength And Mobilization:
Group A patients demonstrated better preservation of quadriceps strength, facilitating early ambulation. In contrast, Group B experienced significant quadriceps weakness, delaying mobilization. Group C patients had moderate muscle strength impairment.

Side Effects:
Group C had a higher incidence of side effects, including hypotension (20%), urinary retention (15%), and nausea (10%) as shown in Table 3. Groups A and B reported minimal side effects, with only occasional reports of mild nausea.

Table 3: Postoperative Side Effects In Studied Groups

Side Effect	Group A (ACB)(n = 30)	Group B (FNB)(n = 30)	Group C (EA)(n = 30)	P-value
Nausea	2 (6.7%)	4 (13.3%)	8 (26.7%)	0.035*
Vomiting	1 (3.3%)	5 (16.7%)	6 (20%)	0.041*
Bradycardia	1 (3.3%)	2 (6.7%)	3 (10%)	0.312
Hypotension	2 (6.7%)	3 (10%)	4 (13.3%)	0.456
Failed Cases	0 (0%)	1 (3.3%)	2 (6.7%)	0.289

*Statistically significant ($P < 0.05$)

DISCUSSION

Pain perception varies from person to person, and predicting postoperative discomfort can be difficult, particularly when the surgical plan changes intraoperatively. Following total knee arthroplasty (TKA), intense pain can not only lead to patient distress but also impede recovery. The extensive tissue trauma inherent in TKA triggers immediate responses from the endocrine, central, peripheral, and sympathetic nervous systems. This response includes the release of stress hormones such as cortisol, glucagon, growth hormone, and catecholamines, which can suppress immune function and increase oxygen consumption, adding cardiovascular strain.

Peripheral nerve blocks have shown superior outcomes in reducing pain and lowering the likelihood of unexpected hospital admissions compared to systemic pain control. The choice between a continuous or single-shot nerve block depends on the extent of the surgical procedure and patient-specific factors.

Among regional anaesthesia options, continuous epidural analgesia (CEA) has traditionally been a cornerstone technique. Peripheral nerve blocks, including femoral and lumbar plexus blocks (with or without sciatic involvement), are also employed, often using paraesthesia or nerve stimulation techniques. Ultrasound-guided approaches are now favoured due to their improved accuracy in needle and catheter placement.

Femoral nerve block (FNB) offers effective analgesia for knee surgeries by interrupting sensory input from the knee. It is often considered the benchmark for postoperative pain control after TKA. However, FNB may impair quadriceps function, increasing the risk of falls in the early postoperative period.

The adductor canal block (ACB) has emerged as an appealing alternative, offering pain relief while preserving motor function of the quadriceps. This technique can lead to reduced hospital stays, faster recovery, and efficient rehabilitation.

This study aimed to compare the effectiveness of continuous ACB, FNB, and epidural analgesia for managing postoperative pain following TKA. The primary focus was on evaluating pain levels, while secondary outcomes included total analgesic consumption, time to first analgesic request, incidence of side effects, and overall patient satisfaction.

The demographic characteristics (age, gender, BMI, and ASA classification) were statistically similar across the groups, as was the surgical duration.

In terms of pain scores using the Numerical Rating Scale (NRS), our findings revealed significantly higher pain scores at 12 and 18 hours in the epidural (Group C) and femoral nerve block (Group B) groups compared to the adductor canal block group (Group A). There was no notable difference between Groups B and C. Pain scores were comparable among all three groups at PACU, and at 2, 4, and 6 hours postoperatively. However, a statistically significant increase in pain scores was noted at 24 hours across all groups.

Our findings align with those of Hanson et al. and Kayupov et al. [10.11], who demonstrated superior pain control in the ACB group. Kayupov's study, in particular, showed lower median pain scores at 18 hours and better overall outcomes with continuous ACB compared to placebo and epidural.

Alsheikh et al. [12] also found higher pain levels in the epidural group compared to the ACB group at 8 hours post-surgery.

Hegazy et al. [13] compared ACB and FNB in TKA patients and observed no significant difference in pain scores at 12 hours. The discrepancy with our findings could be due to their use of a higher single-dose anaesthetic concentration.

Armanious et al. [14] also compared ACB and FNB and found similar pain levels postoperatively, except at 24 hours where FNB yielded lower scores. This may be attributed to the inclusion of epinephrine and higher anaesthetic concentrations.

Regarding the time to first analgesic requirement, our study found it was significantly longer in the ACB group than in the epidural and femoral block groups, which did not differ significantly from each other.

The total morphine dose consumed within the first 24 hours was significantly lower in the ACB group than in the other two groups. No significant difference was noted between the epidural and femoral block groups.

Lund et al. [15] similarly reported low resting pain scores and minimal morphine needs in patients receiving continuous ACB for 48 hours post-TKA. Koh et al. [16] also noted that ACB provided effective analgesia with reduced opioid use and better early mobilization compared to FNB.

Tan et al. [17] also reported no significant opioid consumption differences between ACB and FNB, likely due to the use of epinephrine and high-dose bupivacaine.

In terms of patient satisfaction, those in the ACB group expressed higher satisfaction on the second postoperative day compared to the other two groups.

As for side effects, nausea occurred more frequently in the epidural group. Vomiting, hypotension, bradycardia, and block failure rates did not significantly differ across the groups.

Our findings are consistent with Hegazy [13], Tan [16], and Armanious [14], who noted no significant differences in nausea and vomiting between FNB and ACB. Alsheikh et al. [12] also reported lower nausea and vomiting rates with ACB than with epidural.

In contrast, Fowler et al. [1] observed more frequent hypotension in the epidural group, though nausea and vomiting rates were similar among all groups. Kozian et al. [18] also noted more hypotension in the epidural group than the FNB group, while other side effects were comparable.

Park et al. [19], who studied combined FNB and SNB versus epidural analgesia, found a higher incidence of adverse effects in the epidural group.

Hemodynamically, our study found significant increases in heart rate and mean arterial pressure at 12 and 18 hours postoperatively in the epidural and femoral block groups compared to ACB, with no difference between EG and FNBG. All groups showed similar trends at earlier time points, with a general increase by 24 hours.

While literature comparing these three techniques for hemodynamic outcomes is limited, our results align with Dauri et al. [20], who found no significant hemodynamic differences between continuous epidural and femoral blocks in knee surgery.

Vishwanatha et al. [21] also noted stable hemodynamics between CEA and CFNB using bupivacaine and fentanyl postoperatively. Arjun BK et al. [22] further confirmed hemodynamic stability in patients

receiving ACB combined with sciatic block under ultrasound guidance.

The findings indicate that ACB provides superior postoperative analgesia with minimal motor impairment, facilitating early mobilisation and reducing opioid requirements. FNB, while effective in pain control, is associated with significant quadriceps weakness, delaying rehabilitation. EA offers effective analgesia but is accompanied by higher incidences of systemic side effects.

These results align with previous studies, such as the one by Gawish et al., which concluded that ACB offers better postoperative pain relief with lower NRS scores and reduced morphine consumption compared to FNB and EA.

CONCLUSION

Adductor canal block emerges as the optimal analgesic technique for postoperative pain management in TKA patients, offering effective pain control, preservation of quadriceps strength, and minimal side effects. Its implementation can enhance patient recovery, reduce hospital stays, and improve overall outcomes.

REFERENCES

1. FowlerSJ, SymonsJ, SabatoS, MylesPS. Epidural analgesia compared with peripheral nerve blockade after major knee surgery: a systematic review and meta-analysis of randomized trials. British Journal of Anaesthesia. 2008;100:154–16.
2. Adams HA, Saatweber P, Schmitz CS, Hecker H. Postoperative pain management in orthopaedic patients: no differences in pain score, but improved stress control by epidural anaesthesia. European Journal of Anaesthesiology. 2002;19:658– 65.
3. Burton D, Nicholson G, Hall G. Endocrine and metabolic response to surgery. Continuing Education in Anaesthesia, Critical Care & Pain.2004;4:144 7.
4. Apfelbaum JL, Chen C, Mehta SS, Gan TJ. Postoperative pain experience: results from a national survey suggest postoperative pain continues to be undermanaged. Anesthesia & Analgesia. 2003;97:534-40.
5. Tong D, Chung F, Wong D. Predictive factors in global and 16. anesthesia satisfaction in ambulatory surgical patients. Anaesthesiology. 1997; 87:856–64.
6. Wang L, Guyatt GH, Kennedy SA, et al. Predictors of persistent pain after breast cancer surgery: a systematic review and meta-analysis of observational studies. 17. Canadian Medical Association Journal. 2016;188:352–361
7. Richman JM, Wu CL. Epidural analgesia for postoperative pain. Anaesthesiology. 2005;23:125-40.
8. Paul JE, Arya A, Hurlburt L, et al. Femoral nerve block improves analgesia outcomes after total knee arthroplasty: a meta- analysis of randomized controlled trials. 18. Anaesthesiology. 2010;113:1144–1162.
9. Manickam,B.etal. Feasibility and efficacy of ultrasound-guided block of the saphenous nerve in the adductor canal. Regional Anaesthesia and Pain Medicine.2009;34:578–580.
10. Hanson NA, Allen CJ, Hostetter LS, Nagy R, Derby RE, Slee AE, Arslan A, Auyong DB. Continuous ultrasound-guided adductor canal block for total knee arthroplasty: a randomized, double-blind trial. Anesthesia & Analgesia. 2014; 118(6):1370-7.
11. Kayupov E, Okroj K, Young AC, Moric M, Luchetti TJ, Zisman G, Buvanendran A, Gerlinger TL, Della Valle CJ. Continuous adductor canal blocks provide superior ambulation and pain control compared to epidural analgesia for primary knee arthroplasty: a randomized, controlled trial. The Journal of Arthroplasty. 2018; 33(4): 1040-4
12. Alsheikh K, Alkhelaifi A, Alharbi M, Alhabradi F, Alzahrani F, Alsalim A, et al. Adductor canal blockade versus continuous epidural analgesia after total knee joint replacement: A retrospective cohort study. Saudi Journal of Anaesthesia. 2020;14(1):38-43.
13. Hegazy N, Sultan S. Comparison between effects of adductor canal block and femoral nerve block on early postoperative course in total knee arthroplasty: A prospective double-blind, randomized controlled study. Ain-Shams Journal of Anesthesiology. 2015;8(1):124-8.
14. Armanious SH, Botros JM, El Ganzoury IM, Abdelhameed GA. Adductor canal block versus femoral nerve block in unicompartmental knee arthroplasty: a randomized, double blind, prospective, comparative study. Ain-Shams Journal of Anesthesiology. 2020;12(1):28.
15. Lund J, Jenstrup MT, Jaeger P, Sørensen AM, Dahl JB. Continuous adductor-canal-blockade for adjuvant post-operative analgesia after major knee surgery: preliminary results. Acta anaesthesiologica Scandinavica. 2011;55(1):14-9. Epub 2010/11/03.
16. Koh IJ, Choi YJ, Kim MS, Koh HJ, Kang MS, In Y. Femoral nerve block versus adductor canal block for analgesia after total knee arthroplasty. Knee surgery & related research. 2017;29(2):87-95.
17. Tan Z, Kang P, Pei F, Shen B, Zhou Z, Yang J. A comparison of adductor canal block and femoral nerve block after total- knee arthroplasty regarding analgesic effect, effectiveness of early rehabilitation, and lateral knee pain relief in the early stage. Medicine. 2018;97(48):133-91.
18. Kozian A. Epidural analgesia compared with femoral nerve block for post operative pain therapy after total knee arthroplasty–a matched pair analysis. Journal of Anaesthesia and Surgry. 2019;20(12):150-
19. Park S-J, Shim SY, Park SG. A comparison of continuous femoral nerve block combined with sciatic nerve block and epidural analgesia for postoperative pain management after total knee replacement. Anesthesia Pain Medicine. 2017;12(2):176-82.
20. Dauri M, Polzoni M, Servetti S, Coniglione F, Mariani P, Sabato AF. Comparison of epidural, continuous femoral block and intraarticular analgesia after anterior cruciate ligament reconstruction. Acta Anaesthesiologica Scandinavica. 2003;47(1):20-25.
21. Vishwanatha S, Kalappa S. Continuous femoral nerve blockade versus epidural analgesia for postoperative pain relief in knee surgeries: A randomized controlled study. Anesthesia, Essays Researches. 2017;11(3):599.
22. Arjun BK, Prijith RS, Sreeraghu GM, Narendrababu MC. Ultrasound- guided popliteal sciatic and adductor canal block for below-knee surgeries in high-risk patients. Indian Journal of Anaesthesia. 2019;63(8):635-639.