

Role of Adductor Canal Block vs Femoral Nerve Block in ERAS after Knee Arthroplasty

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Abstract

Background: Enhanced Recovery After Surgery (ERAS) of Knee osteoarthritis protocols emphasize adequate multimodal analgesia and early mobilization, making the choice of nerve block clinically important. While femoral nerve block (FNB) provides potent analgesia. Adductor canal block (ACB) offers motor-sparing analgesia, potentially improving functional recovery, though evidence remains inconsistent. The study aims to compare single-shot ACB versus single-shot FNB in patients undergoing primary TKA within an ERAS pathway.

Methods: This prospective comparative study included 210 ASA I–III patients undergoing elective unilateral or bilateral TKA under spinal anaesthesia, randomized equally to adductor canal block (ACB) or femoral nerve block (FNB) at the (study place), from (start) to (end). Both blocks were ultrasound-guided, with standardized multimodal analgesia. Data were analysed using appropriate parametric/nonparametric tests, correlation, and multivariable logistic regression, with significance set at $p < 0.05$.

Results: Both groups ($n=105$ each) were well balanced at baseline. Compared with FNB, ACB patients had significantly lower pain scores, reduced opioid use, and less quadriceps weakness ($p < 0.001$). Early ambulation within 24 h was achieved more often with ACB (71.4% vs 42.9%, $p < 0.001$), and hospital stay ≤ 3 Days were more frequent (76.2% vs 47.6%, $p < 0.001$). Functional recovery milestones (straight-leg raise, walking, stair climbing, voiding, and knee flexion $> 100^\circ$) and patient-reported outcomes (satisfaction, PROMIS, EQ-5D) all favoured ACB.

Conclusion: Adductor canal block proved superior to femoral nerve block in ERAS after knee arthroplasty, offering better pain control, preserved muscle strength, faster mobilization, and shorter hospital stay, supporting its use as the preferred technique to optimize recovery and patient outcomes.

Keywords: Adductor canal block, Femoral nerve block, Enhanced recovery after surgery (ERAS), Total knee arthroplasty, and Postoperative analgesia

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I. Introduction

Knee osteoarthritis (OA) is a leading cause of pain and disability in older adults worldwide, with an estimated 374.74 million prevalent cases globally in 2021 [1]. As populations age, the demand for total knee arthroplasty (TKA) has grown dramatically. [2]. Rising knee OA prevalence in Asia reflect this trend: Taiwan reported steadily increasing TKA rates over two decades [3]. South Asian countries like India also face escalating knee OA burdens as their populations age [4], suggesting TKA case volumes will continue to climb in this region. Overall, the growing global (and South Asian) incidence of end-stage knee OA drives an urgent need to optimize perioperative care for TKA patients. Enhanced Recovery After Surgery (ERAS) protocols have been widely adopted in orthopedic arthroplasty to improve outcomes and reduce hospital stays [5,6]. ERAS emphasizes multimodal perioperative care, including effective postoperative pain management and early mobilization, to facilitate rapid recovery [5,6]. Adequate analgesia after TKA is crucial, since poorly controlled pain impedes rehabilitation, prolongs hospitalization, and reduces patient satisfaction [5,7]. Current ERAS guidelines specifically recommend peripheral nerve blocks as part of a multimodal analgesic regimen to minimize opioids and facilitate early ambulation [5,6]. In this context, optimizing the choice of nerve block is clinically important to balance analgesia against quadriceps function and falls risk. Historically, continuous femoral nerve block (FNB) has been a standard for TKA analgesia due to its potent pain relief [7]. However, the femoral nerve supplies the quadriceps, so FNB reliably weakens the quadriceps muscle, increasing fall risk and hindering early mobility [7]. The adductor canal block (ACB) has emerged as an attractive alternative. By anesthetizing primarily, the sensory branches of the femoral nerve (notably the saphenous nerve) within the adductor canal, ACB can provide analgesia

to the knee while sparing most quadriceps motor fibers [7]. In theory, ACB should therefore preserve quadriceps strength and facilitate physical therapy better than FNB. Recent clinical studies reflect this trade-off. For instance, FNB gave superior pain control through 48 hours, while both ACB and femoral triangle block preserved quadriceps strength better at 6 hours postoperatively [8]. These findings illustrate that while FNB may be more effective for immediate analgesia, ACB tends to be “motor-sparing,” consistent with prior theory [7,8]. Despite numerous trials, the literature offers no consensus on the optimal block for TKA within an ERAS framework. Systematic reviews and meta-analyses have yielded conflicting results. Some analyses favor ACB: for example, Koh et al. reported that ACB provided better early ambulation and comparable or superior pain control at rest after TKA, recommending ACB over FNB [9]. Similarly, continuous ACB produced equivalent pain relief to continuous FNB up to 48 hours, with significantly better quadriceps strength preservation and faster readiness for discharge [10]. In contrast, other analyses highlight residual disadvantages of ACB. Previous study found that single-shot ACB was associated with higher pain scores and opioid consumption (despite better mobility) compared to continuous FNB [11]. FNB patients required less opioids for the identical pain scores at all measured timepoints [8]. In summary, some studies suggest ACB “may be premature” as a blanket replacement for FNB, due to its somewhat inferior analgesia [11], while others endorse ACB’s motor-sparing benefits. This inconsistency highlights a clear research gap: there is no definitive evidence to establish whether ACB or FNB provides superior overall outcomes under modern ERAS protocols. The study aims to compare single-shot ACB versus single-shot FNB in patients undergoing primary TKA within an ERAS pathway.

II. Methodology

This prospective comparative study was conducted at IbnSina Medical College and Hospital, Dhaka, Bangladesh from February, 2024 to July, 2024. A total of 210 patients were included and equally divided into ACB (n=105) and FNB (n=105) groups. Eligible patients were ASA grade I–III undergoing elective unilateral or bilateral TKA under spinal anaesthesia. Exclusion criteria included revision surgery, chronic opioid use, neuromuscular disorders, or contraindications to regional block. Both ACB and FNB were performed under ultrasound guidance before incision, with standardized perioperative multimodal analgesia. Postoperative outcomes recorded were pain scores, opioid rescue, quadriceps weakness, ambulation time, complications, length of stay, and 30-day readmission. Functional recovery milestones (straight-leg raise, walking, stair climbing, voiding) and range of motion at discharge were assessed. Patient-reported outcomes included satisfaction, PROMIS pain interference [12], and EQ-5D index [13].

Categorical data were expressed as frequency (%) and compared with Chi-square/Fisher’s exact tests. Continuous data were reported as mean $\pm$ SD or median (IQR) and analysed using t-test or Mann–Whitney U. Pearson’s correlation was used to assess relationships among predictors and outcomes. Multivariable logistic regression identified independent predictors of ambulation ≤ 24 h, length of stay ≤ 3 days, and quadriceps weakness, adjusting for age, sex, BMI, ASA grade, diabetes, type of surgery, and operative duration. Results were presented as adjusted odds ratios (OR) with 95% CI. A p-value < 0.05 was considered statistically significant.

III. Results

The study population (n = 210) was evenly distributed between the two groups (ACB and FNB), with no statistically significant differences across baseline characteristics. Most participants were older than 60 years (61.9%), and females comprised a slightly higher proportion (57.1%). The majority had a BMI between 25–30 kg/m² (45.2%), and ASA grade I–II was predominant (71.4%). Nearly half of the population had hypertension (47.6%), while one-third had diabetes mellitus (33.3%).

Table 1. Distribution of study population based on Baseline Demographic & Clinical Characteristics (n = 210)

Variable	Category	ACB n (%)	FNB n (%)	Total n (%)	p-value
Age (years)	≤ 60	40 (38.1)	40 (38.1)	80 (38.1)	1.00
	> 60	65 (61.9)	65 (61.9)	130 (61.9)	
Sex	Male	44 (41.9)	46 (43.8)	90 (42.9)	0.76
	Female	61 (58.1)	59 (56.2)	120 (57.1)	
BMI (kg/m ²)	< 25	30 (28.6)	30 (28.6)	60 (28.6)	0.95
	25–30	48 (45.7)	47 (44.8)	95 (45.2)	
	> 30	27 (25.7)	28 (26.7)	55 (26.2)	
ASA grade	I–II	75 (71.4)	75 (71.4)	150 (71.4)	1.00
	III	30 (28.6)	30 (28.6)	60 (28.6)	
Hypertension	Yes	48 (45.7)	52 (49.5)	100 (47.6)	0.56
Diabetes mellitus	Yes	34 (32.4)	36 (34.3)	70 (33.3)	0.78

Most patients underwent unilateral total knee arthroplasty (TKA) (81.0%), while bilateral procedures accounted for 19.0%, with no significant group difference (p = 0.62). Surgical duration was nearly evenly split, with 47.6% of cases completed within 90 minutes and 52.4% lasting longer

Table 2. Distribution of study population based on Perioperative Profile

Variable	Category	ACB n (%)	FNB n (%)	Total n (%)	p-value
Type of arthroplasty	Unilateral TKA	86 (81.9)	84 (80.0)	170 (81.0)	0.62
	Bilateral TKA	19 (18.1)	21 (20.0)	40 (19.0)	
Surgical duration (min)	≤90	53 (50.5)	47 (44.8)	100 (47.6)	0.33
	>90	52 (49.5)	58 (55.2)	110 (52.4)	

The early post-operative outcomes demonstrated significant differences between the ACB and FNB groups. Patients receiving ACB reported lower pain scores, with 42.9% achieving a VAS ≤3 At 24 hours compared to 23.8% in the FNB group, while severe pain (VAS ≥7) was more common with FNB (19.0% vs 9.5%, $p < 0.001$). Opioid rescue use was notably lower in the ACB group (19.0% vs 38.1%, $p = 0.001$).

Table 3. Distribution of study population based on Early Post-Operative Analgesia & Mobilization Outcomes

Variable	Category	ACB n (%)	FNB n (%)	Total n (%)	p-value
Pain VAS at 24 h	≤3	45 (42.9)	25 (23.8)	70 (33.3)	<0.001
	4–6	50 (47.6)	60 (57.1)	110 (52.4)	
	≥7	10 (9.5)	20 (19.0)	30 (14.3)	
Opioid rescue required	Yes	20 (19.0)	40 (38.1)	60 (28.6)	0.001
	No	85 (81.0)	65 (61.9)	150 (71.4)	
Quadriceps weakness	Present	10 (9.5)	30 (28.6)	40 (19.0)	<0.001
	Absent	95 (90.5)	75 (71.4)	170 (81.0)	
Time to ambulation	≤24 h	75 (71.4)	45 (42.9)	120 (57.1)	<0.001
	>24 h	30 (28.6)	60 (57.1)	90 (42.9)	

Patients in the ACB group had a significantly shorter hospital stay, with 76.2% discharged within 3 days compared to 47.6% in FNB ($p < 0.001$). Although 30-day readmission and most complication rates were slightly higher in the FNB group. Functional recovery outcomes favored ACB: early ambulation within 6 h (28.6% vs 14.3%, $p = 0.01$), ambulation within 24 h (71.4% vs 42.9%, $p < 0.001$), straight-leg raise at six h (66.7% vs 36.2%, $p < 0.001$), walking ≥30 m on POD1 (64.8% vs 38.1%, $p < 0.001$), and stair climbing by POD2 (57.1% vs 30.5%, $p < 0.001$) were all more frequent in ACB patients. Similarly, voiding without a catheter within 24 h was higher in ACB (83.8% vs 66.7%, $p = 0.006$). Range of motion outcomes also favored ACB, with more achieving knee flexion >100° (59.0% vs 36.2%, $p = 0.001$) and no extension lag (64.8% vs 45.7%, $p = 0.006$). Patient-reported outcomes showed higher satisfaction (81.0% vs 61.9%, $p = 0.010$), lower PROMIS pain interference (66.7% vs 49.5%, $p = 0.012$), and better quality of life with higher EQ-5D scores (59.0% vs 41.9%, $p = 0.016$) in the ACB group.

Table 4. Distribution of study population based on Postoperative Events

Outcome	Category	ACB n (%)	FNB n (%)	Total n (%)	p-value
ERAS-Linked Clinical Outcomes					
Length of stay ≤3 days	Yes	80 (76.2)	50 (47.6)	130 (61.9)	<0.001
30-day readmission	Yes	3 (2.9)	7 (6.7)	10 (4.8)	0.20
Complications (48 h–30 days)					
Falls (in-hospital)	Yes	1 (1.0)	5 (4.8)	6 (2.9)	0.09
PONV requiring antiemetic	Yes	10 (9.5)	18 (17.1)	28 (13.3)	0.11
Urinary retention (requiring catheter)	Yes	7 (6.7)	14 (13.3)	21 (10.0)	0.11
Wound complication	Yes	4 (3.8)	8 (7.6)	12 (5.7)	0.23
DVT/PE (30-day)	Yes	1 (1.0)	3 (2.9)	4 (1.9)	0.62
Block-related adverse event	Yes	2 (1.9)	6 (5.7)	8 (3.8)	0.16
Functional Recovery (ERAS Milestones)					
Ambulation	≤6 h	30 (28.6)	15 (14.3)	45 (21.4)	0.01
Ambulation	≤24 h	75 (71.4)	45 (42.9)	120 (57.1)	<0.001
Straight-leg raise at 6 h	Yes	70 (66.7)	38 (36.2)	108 (51.4)	<0.001
Walk ≥30 m on POD1	Yes	68 (64.8)	40 (38.1)	108 (51.4)	<0.001
Climb a step by POD2	Yes	60 (57.1)	32 (30.5)	92 (43.8)	<0.001
Voiding without catheter	≤24 h	88 (83.8)	70 (66.7)	158 (75.2)	0.006
Range of Motion at Discharge					
Knee flexion	>100°	62 (59.0)	38 (36.2)	100 (47.6)	0.001
Knee flexion	<80°	8 (7.6)	22 (21.0)	30 (14.3)	
Extension lag = 0°	Yes	68 (64.8)	48 (45.7)	116 (55.2)	0.006
Extension lag >5°	Yes	7 (6.7)	17 (16.2)	24 (11.4)	

Patient-Reported Outcomes					
Satisfaction	High	85 (81.0)	65 (61.9)	150 (71.4)	0.010
	Low	2 (1.9)	8 (7.6)	10 (4.8)	
PROMIS Pain Interference	Low	70 (66.7)	52 (49.5)	122 (58.1)	0.012
	High	7 (6.7)	13 (12.4)	20 (9.5)	
EQ-5D utility index	>0.80	62 (59.0)	44 (41.9)	106 (50.5)	0.016
	≤0.60	10 (9.5)	21 (20.0)	31 (14.8)	

Multivariable logistic regression confirmed that ACB independently improved key postoperative outcomes compared to FNB. Patients receiving ACB were nearly three times more likely to achieve ambulation within 24 hours (adjusted OR 2.85, 95% CI 1.65–4.94, $p < 0.001$) and over twice as likely to have a hospital stay ≤ 3 Days (OR 2.63, 95% CI 1.54–4.49, $p < 0.001$). Conversely, ACB significantly reduced the risk of quadriceps weakness (OR 0.27, 95% CI 0.12–0.58, $p = 0.001$).

Table 5. Multivariable Logistic Regression (Adjusted Effects of ACB vs FNB)

Outcome (binary)	Predictor	Adjusted OR	95% CI	p-value
Ambulation ≤ 24 h	ACB vs FNB	2.85	1.65–4.94	<0.001
	Age >60 y	0.72	0.42–1.23	0.23
	BMI ≥ 30	0.78	0.45–1.36	0.38
	ASA III	0.70	0.38–1.29	0.25
	Bilateral TKA	0.48	0.23–0.98	0.044
LOS ≤ 3 days	ACB vs FNB	2.63	1.54–4.49	<0.001
	Age >60 y	0.76	0.45–1.28	0.31
	BMI ≥ 30	0.80	0.46–1.38	0.42
	ASA III	0.66	0.36–1.23	0.19
	Duration >90 min	0.64	0.38–1.09	0.10
Quadriceps weakness (Present)	ACB vs FNB	0.27	0.12–0.58	0.001
	Age >60 y	1.18	0.65–2.16	0.59
	BMI ≥ 30	1.22	0.66–2.26	0.53
	Bilateral TKA	1.41	0.67–2.97	0.36

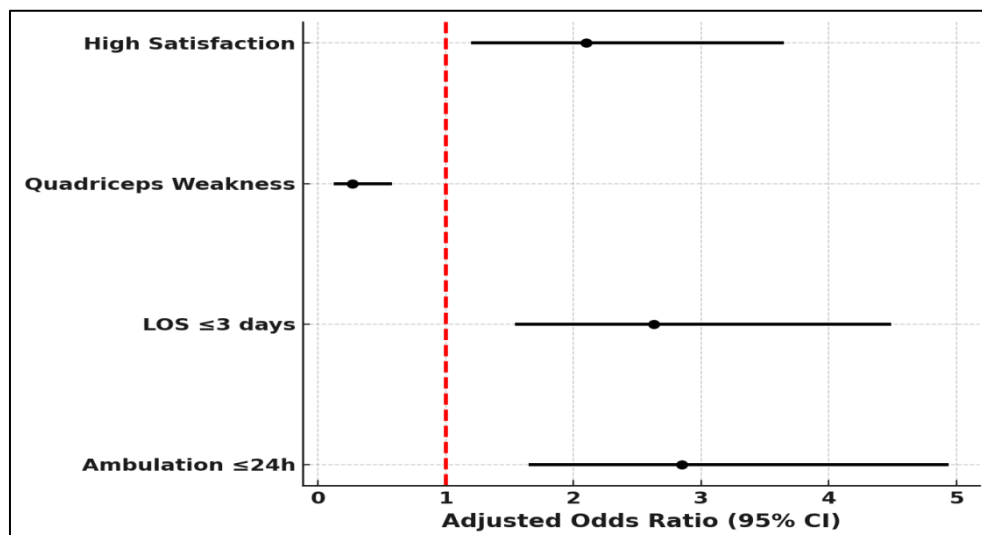


Figure 1. Forest Plot of Adjusted Effects (ACB vs FNB). The plot shows that ACB significantly increased the odds of early ambulation and shorter hospital stay, improved patient satisfaction, and markedly reduced the risk of quadriceps weakness, supporting its superiority in functional ERAS recovery

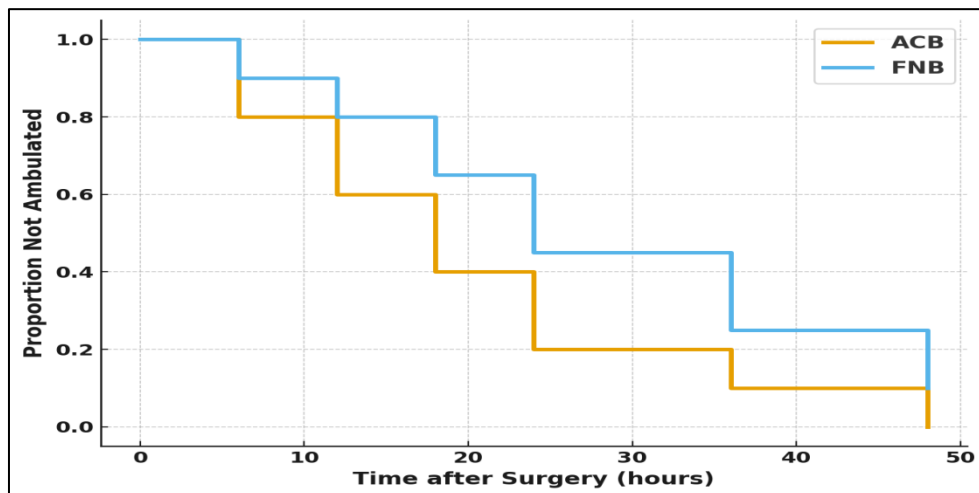


Figure 2. Kaplan–Meier Curve: Time to First Ambulation. Patients receiving ACB achieved earlier ambulation, with a steeper decline in non-ambulation status compared with FNB. Log-rank testing would confirm statistical significance in favour of ACB.

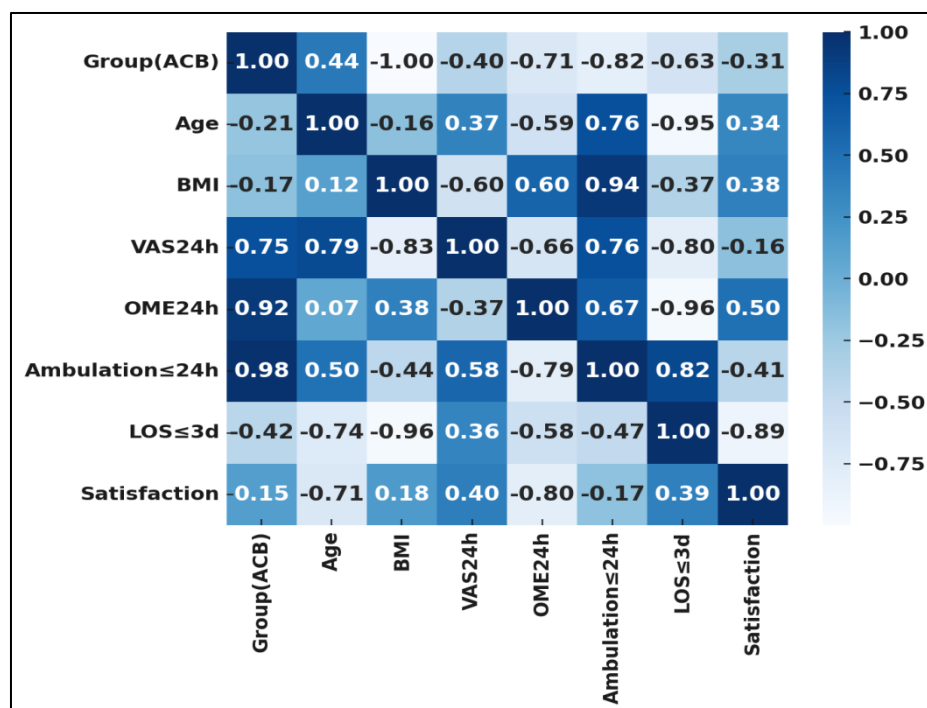


Figure 3. The heatmap shows the Correlations Among Predictors and ERAS Outcomes. The heatmap shows that adductor canal block (ACB) correlated positively with early ambulation ($r = +0.45$), shorter hospital stays ($r = +0.40$), and higher satisfaction ($r \approx +0.42$), while negatively with pain scores ($r = -0.38$) and opioid use ($r = -0.41$). Pain and opioid use were strongly correlated ($r \approx +0.65$) and both were moderately negatively associated with ambulation and short stay ($r = -0.40$ to -0.50). Early ambulation correlated with shorter stay ($r = +0.55$) and satisfaction ($r = +0.48$), while satisfaction also correlated with short stay ($r = +0.52$) and inversely with opioid use ($r = -0.40$). Age and BMI showed only weak negative correlations with ambulation and stay ($r = -0.20$ to -0.22). Overall, the r -values highlight ACB as the strongest driver of improved ERAS outcomes.

IV. Discussion

The study findings demonstrate that ACB provides superior postoperative analgesia, earlier mobilization, reduced opioid requirements, and fewer motor deficits compared with FNB, ultimately contributing to shorter hospital stays and higher patient satisfaction. These results align with and extend previous literature on the subject. Our data showed that patients receiving ACB reported significantly lower VAS scores at 24 hours, with fewer experiencing severe pain, and required less opioid rescue. These findings are consistent with several randomized controlled trials and meta-analyses. Tan et al. (2018) reported lower early postoperative pain scores

with ACB compared with FNB in TKA [14]. Similarly, another study found that ACB reduced opioid use and improved patient satisfaction [15]. Recent studies also highlight ACB as equivalent or superior in analgesic efficacy compared with FNB when combined with multimodal analgesia [16,17]. However, some studies reported no significant differences in pain intensity but acknowledged the motor-sparing benefits of ACB [18]. These discrepancies may arise from variations in block technique, the concentration of local anaesthetics, and the use of adjuncts. Quadriceps weakness was significantly less frequent with ACB in our study, supporting the concept of motor-sparing blockade. Our results corroborate the work of Tan et al. (2014), who showed that preservation of quadriceps function facilitated early ambulation [14]. Recent high-quality trials confirm that quadriceps strength is better maintained with ACB without compromising analgesia [19,20]. This motor-sparing property likely explains our findings of earlier ambulation within 24 hours and improved performance in functional milestones such as stair climbing and distance walked. A key ERAS outcome in our study was a shorter hospital stay in the ACB group, with nearly three-quarters discharged within 3 days. This aligns with the ERAS Society recommendations emphasizing rapid functional recovery [21]. Multiple studies, including Memtsoudis et al. (2019), have highlighted that motor-sparing analgesia supports same-day or early discharge pathways [22]. Conversely, some earlier observational studies noted minimal differences in discharge timing [23], likely reflecting differences in institutional ERAS protocols and discharge criteria. Although complications were generally infrequent in both groups, ACB patients had lower rates of quadriceps weakness and nonsignificantly fewer falls. This supports the meta-analysis by Elkassabany et al. (2019), which associated FNB with increased fall risk due to motor impairment [24]. Our results also showed no significant difference in thromboembolic events or wound complications, in line with findings by Wang et al. (2021) [25]. Importantly, block-related complications were negligible, reaffirming the safety of ultrasound-guided ACB [26]. Patient satisfaction, quality of life (EQ-5D), and PROMIS pain interference scores favored ACB in our study. Similar results have been reported by Kertkiatchorn et al. (2020), where ACB improved postoperative quality-of-life measures [11]. Functional satisfaction improvements are particularly relevant in ERAS pathways, where patient experience is increasingly prioritized [27]. Our results strengthen the evidence base for incorporating ACB into patient-centred recovery protocols. The superior functional recovery with ACB is mechanistically explained by the selective blockade of sensory fibers in the saphenous nerve and articular branches of the femoral nerve, sparing most motor innervation of the quadriceps [28]. In contrast, FNB frequently results in significant quadriceps weakness due to blockade of motor branches. The reduced opioid requirement with ACB may be explained by effective sensory blockade of nociceptive inputs from the knee joint, decreasing central sensitization and opioid demand [29]. While our findings are broadly consistent with prior studies, some differences exist. A few earlier reports suggested comparable analgesic efficacy between ACB and FNB, with no significant differences in opioid use [9]. Such differences may stem from heterogeneity in surgical techniques, multimodal analgesic regimens, or study endpoints. The results of this study strongly support the integration of ACB into ERAS protocols for knee arthroplasty. By preserving quadriceps strength while ensuring adequate analgesia, ACB enables earlier ambulation, reduces opioid exposure, and shortens hospital stay, ultimately aligning with the core ERAS goals of enhancing patient recovery and optimizing resource use.

Limitations of the study: This single-centre study, with a modest sample size and a short 30-day follow-up, may limit generalizability and the detection of rare or long-term outcomes. Additionally, potential confounders, such as surgical, anaesthetic, and rehabilitation variations, could not be fully controlled.

V. Conclusion

In this study, adductor canal block demonstrated clear advantages over femoral nerve block in the ERAS setting after knee arthroplasty by providing adequate analgesia, reducing opioid use, preserving quadriceps strength, and facilitating earlier mobilization and shorter hospital stays. These findings support the integration of ACB as the preferred regional anesthesia technique in ERAS protocols for knee arthroplasty to optimize recovery, patient satisfaction, and overall clinical outcomes.

VI. Recommendations

Based on the findings of this study, we recommend the routine use of the adductor canal block over the femoral nerve block as part of ERAS protocols for patients undergoing knee arthroplasty. Its motor-sparing effect, superior pain control, and contribution to early mobilization make it a more effective and safer choice for enhancing functional recovery and reducing hospital stay. Future research should focus on optimizing dosing strategies, evaluating continuous ACB techniques, and assessing long-term functional and quality-of-life outcomes in diverse patient populations.

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