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Original Article

ANALGESIC EFFICACY OF ADDUCTOR CANAL BLOCK COMBINED WITH GENICULAR NERVE BLOCK AFTER TOTAL KNEE ARTHROPLASTY: A PRELIMINARY CASE SERIES

Dao Ngo Quyen[1], Nguyen Anh Tung[1], Nguyen Thi Hien[1]

1. Department of Surgery, Anesthesiology and Critical Care, Thong Nhat Hospital, Ho Chi Minh City, Vietnam

** Corresponding author: Dao Ngo Quyen ✉ ngoquyen.yd@gmail.com*

ABSTRACT: To evaluate the preliminary efficacy, opioid-sparing effect, and safety of ultrasound-guided adductor canal block (ACB) combined with genicular nerve block in total knee arthroplasty (TKA). This was a prospective case series of 21 patients undergoing primary TKA who received a preoperative 4-branch genicular nerve block and a postoperative single-injection ACB. Resting VAS scores (0–48h), cumulative 48-hour fentanyl consumption, complications, and satisfaction were recorded. Patients (95.2% female, mean age 66.1 ± 6.3 years) showed maximal pain relief at 6h (VAS 0.81 ± 0.60), followed by rebound pain at 24h (3.24 ± 0.83; $p < 0.001$) that remained stable through 48h (3.14 ± 0.79). Mean 48-hour fentanyl consumption was 121 ± 34.6 mcg. No procedural complications occurred, and 95.2% of patients were satisfied or very satisfied. Combined ACB and genicular nerve block provides safe and effective early analgesia after TKA (6–12h) and reduces opioid requirements. Proactive multimodal systemic analgesia is required to manage rebound pain at 12–24 hours.

Keywords: total knee arthroplasty, adductor canal block, genicular nerve block, postoperative analgesia, rebound pain, ACB.

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1. BACKGROUND AND INTRODUCTION

Total knee arthroplasty (TKA) is a common orthopedic procedure that improves mobility and quality of life in patients with end-stage knee osteoarthritis, particularly as populations age rapidly [1]. However, the operation is consistently followed by severe acute postoperative pain [1, 2]. Inadequately controlled pain causes sympathetic stimulation, myocardial ischemia, impaired respiratory function, and a higher risk of infection and thromboembolism. It also delays early mobilization, prolongs hospital stay, and increases the risk of chronic postsurgical pain [1, 2]. In older adults, severe postoperative pain is a leading risk factor for delirium and anxiety disorders [1].

Analgesic options after TKA include epidural analgesia, intrathecal morphine, peripheral nerve blocks, and intravenous and oral analgesics. Among these, regional anesthesia is the foundation of multimodal analgesia. The innervation of the knee is highly complex, arising from the main branches of the femoral, sciatic, and obturator nerves. Blocking these nerves and their terminal branches is the key to effective analgesia for knee surgery [1, 2].

In 2020, the PROSPECT (PROcedure SPEcific Postoperative Pain ManagemenT) working group of the European Society of Regional Anaesthesia and Pain Therapy (ESRA) issued clinical practice recommendations on pain management after TKA [2]. According to these recommendations, epidural analgesia, although effective, is no longer recommended routinely because it increases postoperative nausea and vomiting (PONV), hypotension, urinary retention, and bilateral lower-limb motor block, and it hinders early recovery [2]. Intrathecal morphine should be considered only when peripheral regional techniques cannot be performed. Femoral nerve block (FNB) provides analgesia comparable to epidural analgesia but causes marked quadriceps weakness, which delays ambulation and increases the risk of falls [2]. Adductor canal block (ACB), introduced in 2011 and widely adopted in Vietnam in recent years, provides good analgesia while almost fully preserving quadriceps strength [1-6]. Adding a sciatic nerve block to ACB improves posterior knee analgesia but increases the risk of lower-leg weakness (foot drop) and hinders early mobilization [2]. More recently, ACB has been combined with newer techniques such as local infiltration analgesia (LIA), infiltration between the popliteal artery and the capsule of the posterior knee (iPACK), or genicular nerve block to improve anterior capsular analgesia without causing motor block [2, 5, 7-11]. Combining ACB with genicular nerve block allows a lower local anesthetic dose and precisely targeted analgesia [7].

In Vietnam, adductor canal block combined with genicular nerve block is still relatively new, and few data have been published. We therefore conducted this study as a preliminary, hypothesis-generating clinical report with the following specific objectives:

1. To describe the clinical and surgical characteristics and procedure times of patients undergoing knee arthroplasty.

2. To assess resting pain using the VAS at predefined time points (0h, 30 minutes, 1h, 2h, 3h, 6h, 9h, 12h, 24h, 48h), fentanyl requirements over 48 hours, and complications after the blocks.

3. To assess patient satisfaction with the analgesic method.

2. SUBJECTS AND METHODS

2.1. Study design:

Prospective, hypothesis-generating descriptive case series without a control group.

2.2. Study period and setting:

The study was conducted at the Department of Surgery, Anesthesiology and Critical Care, Thong Nhat Hospital, from March 2025 to September 2025.

2.3. Study population:

Patients aged 18 years or older diagnosed with severe knee osteoarthritis and scheduled for primary total knee arthroplasty at Thong Nhat Hospital.

2.4. Inclusion criteria:

Age ≥ 18 years.

ASA physical status I – III.

Voluntary consent to participate and ability to cooperate with pain score assessment.

No contraindication to peripheral regional anesthesia.

No progressive peripheral neuropathy and no chronic lower-limb pain treated with opioids.

Exclusion criteria: refusal by the patient or guardian; infection at the needle insertion site; allergy to amide local anesthetics; history of spinal cord injury or injury to the nerves supplying the lower limb; psychiatric disorders or dementia preventing self-assessment of the VAS; severe coagulopathy.

Sample size and sampling: All eligible patients treated in the department during the study period were consecutively enrolled. Complete data were collected and analyzed for 21 patients.

2.5. Research ethics:

The study was approved by the Biomedical Research Ethics Committee of Thong Nhat Hospital (decision QĐ233/QĐ-BVTN, 2024). All patients received a clear explanation of the benefits, procedures, and possible complications before signing written informed consent.

2.6. Equipment and procedures:

Preparation: Patients underwent a preanesthetic assessment, received an explanation of the techniques, and were taught to use the VAS (0: no pain to 10: severe pain). Equipment included a GE Healthcare ultrasound machine with a 5–12 MHz linear probe, dedicated nerve block needles (Stimuplex Ultra 22G x 80mm), 0.25% ropivacaine, and resuscitation equipment for local anesthetic systemic toxicity (20% lipid emulsion).

Procedure 1: Genicular nerve block – performed BEFORE surgery:

- Performed in the preanesthesia room before skin incision. Under ultrasound guidance, the bony landmarks and corresponding vessels of the 4 genicular nerve branches were identified:

- Superomedial genicular nerve (SMGN): at the junction of the femoral shaft and the medial femoral condyle.

- Superolateral genicular nerve (SLGN): at the junction of the femoral shaft and the lateral femoral condyle.

- Inferomedial genicular nerve (IMGN): at the junction of the tibial shaft and the medial tibial condyle.

- Inferolateral genicular nerve (ILGN): above the fibular head.

- At each site, after negative aspiration for blood, 4 ml of 0.25% ropivacaine was injected (total volume 16 ml). Criterion for a successful sensory block: after 15–20 minutes, a cold test was performed with alcohol-soaked cotton; the block was considered successful when the patient had lost or clearly reduced cold sensation in the corresponding skin areas of the anterior knee compared with the opposite side.

Procedure 2: Surgical anesthesia: spinal anesthesia at the L3–L4 interspace in the sitting or lateral position with 7–8 mg of hyperbaric 0.5% bupivacaine.

Procedure 3: Adductor canal block (ACB) – performed AFTER surgery: The block was performed in the recovery room immediately after surgery, when the patient began to regain lower-limb movement but had not yet developed pain. The ultrasound probe was placed at the middle third of the thigh to identify the femoral artery beneath the sartorius muscle. The needle was advanced in-plane from lateral to medial, with the tip placed next to the superficial femoral artery within the adductor canal. A volume of 15 ml of 0.25% ropivacaine was injected, with aspiration every 5 ml to avoid intravascular injection. Vital signs and symptoms of local anesthetic toxicity were monitored continuously after injection.

Multimodal analgesic regimen and monitored variables:

Baseline analgesia: intravenous paracetamol 1g every 8 hours plus oral celecoxib 200mg every 12 hours, and nefopam 20mg by slow intravenous infusion every 4 hours unless contraindicated.

Rescue pain treatment: Resting VAS was assessed at 10 time points: 0h, 30 minutes, 1h, 2h, 3h, 6h, 9h, 12h, 24h, and 48h after the ACB. When patients had pain with VAS ≥ 4, intravenous fentanyl 25–50 mcg per dose was given. The time of pain recurrence and the total fentanyl dose over 48 hours were recorded.

Complications: local anesthetic systemic toxicity (LAST), hematoma at the injection site, intravascular injection, allergy, infection, and opioid-induced respiratory depression were recorded. - Satisfaction: assessed at 48 hours using a 5-item questionnaire on a 5-point Likert scale (from 1: very dissatisfied to 5: very satisfied). The total score ranged from 5 to 25. Categories: very satisfied (21–25 points), satisfied (16–20 points), dissatisfied (≤ 15 points).

Patient satisfaction criteria:

1. Degree of pain relief after the block (1: very poor – 5: very good).

2. Comfort during the postoperative period (1: very uncomfortable – 5: very comfortable).

3. Attitude and professional skills of the performing physician (1: very dissatisfied – 5: very satisfied).

4. Side effects (if any) after the block (1: very many side effects – 5: none at all).

5. Willingness to receive the method again and recommend it to others (1: not at all – 5: very willing).

2.7. Data analysis:

Data were entered and analyzed using SPSS 26.0.

Categorical variables are presented as frequencies (n) and percentages (%).

Normally distributed continuous variables are presented as mean ± standard deviation (mean ± SD).

Changes in VAS scores across repeated time points were analyzed with the Friedman test.

Pairwise comparisons between key time points (0h vs. 6h; 6h vs. 24h; 24h vs. 48h) were performed with the Wilcoxon signed-rank test, with 95% confidence intervals (95% CI) calculated for the mean differences.

Statistical significance was set at $p < 0.05$.

3. RESULTS

Patient characteristics: We studied 21 patients undergoing primary total knee arthroplasty; their clinical and procedural characteristics are shown in Table 1.

Clinical and surgical characteristics (n = 21)	Value (mean ± SD / n, %)
Age (years)	66.1 ± 6.3
Sex (female / male)	20 (95.2%) / 1 (4.8%)
Body mass index - BMI (kg/m^2)	26.4 ± 2.1
ASA class (ASA II / ASA III)	13 (61.9%) / 8 (38.1%)
Genicular nerve block time (seconds)	617 ± 43 (600 – 720)
Adductor canal block time (seconds)	226 ± 46 (180 – 300)
Operative time (minutes)	93.1 ± 10.9 (75 – 110)

The mean age was 66.1 ± 6.3 years, and nearly all patients were female (20/21, 95.2%). In terms of ASA class, 13 patients were ASA II (61.9%) and 8 were ASA III (38.1%). The mean BMI was 26.4 ± 2.1 kg/m^2, indicating that most patients were mildly overweight. The mean time to perform the genicular nerve block was 617 ± 43 seconds (range 600 – 720 seconds, about 10 minutes), and the mean time to perform the adductor canal block was 226 ± 46 seconds (range 180 – 300 seconds, nearly 4 minutes). The mean operative time was 93.1 ± 10.9 minutes (range 75 – 110 minutes).

Postoperative VAS scores: Resting VAS scores fell rapidly and markedly during the first 6 hours after the blocks, reaching a nadir at 6h, then gradually rose until 24 hours and remained stable up to 48 hours after surgery. The Friedman test showed highly significant differences in VAS scores across time points ($p < 0.001$).

Time points compared	Earlier VAS (mean ± SD)	Later VAS (mean ± SD)	Mean difference (95% CI)	p value (Wilcoxon)
0h vs. 6h	1.90 ± 1.18	0.81 ± 0.60	-1.09 (-1.62 to -0.56)	0.004

6h vs. 24h	0.81 ± 0.60	3.24 ± 0.83	+2.43 (+2.01 to +2.85)	< 0.001
24h vs. 48h	3.24 ± 0.83	3.14 ± 0.79	-0.10 (-0.44 to +0.24)	0.625

Pairwise Wilcoxon signed-rank tests showed a significant decrease in VAS from 0h to 6h ($p = 0.004$) and a clearly significant increase from 6h to 24h ($p < 0.001$), with a mean increase of 2.43 points (95% CI: 2.01 to 2.85 points). VAS scores at 24h and 48h did not differ significantly ($p = 0.625$).

Opioid consumption: In our study, 19/21 patients (90.5%) required rescue opioids, mainly intravenous fentanyl, at a mean dose of 121 ± 34.6 mcg over 48 hours (range 100 to 200 mcg). In addition, 2 patients (9.5%) received oral tramadol 200 – 400 mg. No patient required morphine or high-dose sufentanil.

Complications after the blocks: Throughout the 48-hour follow-up, we recorded no block-related complications such as local anesthetic systemic toxicity (LAST), allergy, injection-site infection, persistent sensory nerve injury, or vascular puncture. No patient developed opioid-induced respiratory depression or circulatory depression.

Postoperative patient satisfaction:

Criterion	Likert score (1 - 5)	Frequency n (%)
1. Pain relief after the block	Score 3 (Neutral) Score 4 (Satisfied) Score 5 (Very satisfied)	3 (14.3%) 14 (66.7%) 4 (19.0%)
2. Postoperative comfort	Score 3 (Neutral) Score 4 (Satisfied) Score 5 (Very satisfied)	3 (14.3%) 14 (66.7%) 4 (19.0%)
3. Physician attitude and skills	Score 3 (Neutral) Score 4 (Satisfied) Score 5 (Very satisfied)	1 (4.8%) 17 (80.9%) 3 (14.3%)
4. Side effects after the block	Score 3 (Few) Score 4 (Very few) Score 5 (None at all)	1 (4.8%) 18 (85.7%) 2 (9.5%)
5. Willing to reuse / recommend	Score 2 (Slightly willing) Score 3 (Undecided) Score 4 (Willing) Score 5 (Very willing)	1 (4.8%) 2 (9.5%) 16 (76.2%) 2 (9.5%)

Overall satisfaction scores: The mean satisfaction score was 20.1 ± 1.9 points (out of a maximum of 25). In total, 12 patients were satisfied (57.1%), 8 were very satisfied (38.1%), and only 1 patient (4.8%) was dissatisfied. The single dissatisfied patient (total score 15/25) reported sudden sharp pain at night (about 18–20 hours after surgery) as the block wore off, before rescue analgesia could be given.

4. DISCUSSION

Our study showed that combining adductor canal block with genicular nerve block provided very good analgesia after total knee arthroplasty. The mean baseline VAS was about 1.90, fell to its lowest level 6 hours after the blocks (VAS ≈ 0.81), then rose again at 12–24 hours (VAS ≈ 3.24) and remained stable up to 48 hours. The Friedman test showed significant differences between time points ($p < 0.001$). Pairwise comparisons showed a significant decrease in VAS from 0h to 6h ($p = 0.004$) and a rise from 6h to 24h ($p < 0.001$), whereas scores at 24h and 48h did not differ significantly ($p = 0.625$).

This combined technique therefore provides its best pain control in the first 6–12 hours after the blocks, allowing a smooth recovery and supporting early in-bed mobilization after surgery without quadriceps weakness [1, 5]. However, the key finding of this study is the sharp rise in pain scores from 6 hours to 24 hours (mean difference 2.43 points, 95% CI:

2.01 – 2.85). This 'rebound pain' can be explained by two factors. First, the analgesic effect of a single perineural injection of 0.25% ropivacaine usually lasts only 10–14 hours; as the drug concentration falls below the receptor-blocking threshold, nociceptive input from the operated knee returns. Second, the two techniques were performed at different times: the genicular nerve block was performed BEFORE surgery (in the preanesthesia room), whereas the ACB was performed AFTER surgery (in the recovery room). Because of this time gap, the sensory block of the 4 genicular nerve branches wears off earlier than the ACB. When the genicular block wears off at about 10–12 hours after surgery, the ACB alone cannot block the complex pain arising from the anterolateral and anteromedial capsule [7, 8]. This points to a practical lesson: clinicians should give scheduled systemic analgesics (paracetamol, nonsteroidal anti-inflammatory drugs, oral opioids, and gabapentin) before the 12-hour mark.

Opioid requirements over 48 hours were relatively low, consisting mainly of intravenous fentanyl at a mean dose of 121 ± 34.6 mcg (equivalent to about 12 mg of intravenous morphine). Although the study had no internal control group, comparison with the international literature and with reports of conventional TKA using morphine PCA (typically 25–40 mg of morphine in the first 48 hours) [1, 2] shows that the combined technique contributed substantially to an opioid-sparing effect. As a result, we minimized typical opioid side effects such as respiratory depression, excessive sedation, nausea, vomiting, and urinary retention.

In addition, we recorded no block-related complications such as local anesthetic systemic toxicity, vascular puncture, allergy, or infection, showing that the technique is highly safe when performed under ultrasound guidance by experienced physicians [10, 11]. Patient satisfaction was very high (95.2% satisfied or very satisfied; mean score 20.1 ± 1.9), reflecting patient comfort and the practical value of the technique. The only dissatisfied patient (4.8%) had rebound pain at night, which shows the importance of multimodal analgesia built on regional anesthesia.

Study limitations: First, this was a prospective descriptive case series without a randomized control group (for example, a direct comparison with ACB alone or ACB combined with LIA/iPACK); the study is therefore only hypothesis-generating and cannot establish the superiority of the method. Second, the sample was small (21 patients) and was obtained by consecutive enrollment without a prior power calculation, so the statistical tests are at risk of type II error. Third, follow-up ended at 48 hours, and detailed motor function outcomes such as quadriceps strength and knee range of motion (ROM) were not assessed.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

In 21 patients undergoing total knee arthroplasty at Thong Nhat Hospital, ultrasound-guided adductor canal block combined with genicular nerve block provided very good early analgesia during the first 6–12 hours after surgery, substantially reduced opioid requirements, had a high level of procedural safety, and achieved high patient satisfaction. However, pain increased again at 24 hours as the single-injection local anesthetic wore off and the genicular block regressed early; clinicians should be aware of this.

5.2. Recommendations

- In clinical practice: Genicular nerve block can be combined with ACB as part of a motor-sparing multimodal analgesic strategy; scheduled systemic analgesics should also be started before 12 hours after surgery to control rebound pain.
- In research: Larger randomized controlled trials (RCTs) with a prior power calculation are needed to compare ACB + genicular nerve block directly with ACB alone or ACB combined with LIA/iPACK, and to evaluate functional recovery (time to independent ambulation, quadriceps strength) and cost-effectiveness.

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