https://doi.org/10.59459/1859-1655/JMM.835

EVALUATION OF ANALGESIC EFFICACY FOLLOWING RENAL TRANSPLANTATION USING BUPIVACAINE-FENTANYL MIXTURE VIA PATIENT-CONTROLLED EPIDURAL ANALGESIA

Tran Dac Tiep[1*], Trinh Van Duc[1], Nguyen Ngoc Thach[1]
Nguyen Truong An[2], Truong Xuan Bach[2]

ABSTRACT

Objectives: *To evaluate the analgesic efficacy of a bupivacaine-fentanyl mixture administered via patient-controlled epidural analgesia (PCEA) following renal transplantation.*

Subjects and methods: *A cross-sectional descriptive study was conducted on 50 patients who underwent renal transplantation at Military Hospital 103 and received postoperative analgesia using a bupivacaine-fentanyl mixture via PCEA. Analgesic efficacy was assessed using the visual analog scale (VAS), total drug consumption, number of PCEA demands and successful attempts, and time to first rescue analgesic request.*

Results: *Resting VAS pain scores decreased progressively over time, from 3.96 ± 0.49 at baseline (H0) to 2.1 ± 0.76 at 24 hours and 1.54 ± 0.78 at 72 hours postoperatively ($p < 0.05$). Mean bupivacaine and fentanyl doses were highest on the first postoperative day and declined on subsequent days. The mean number of PCEA demands peaked on postoperative day one (15.36 ± 2.31 attempts). The mean time to first rescue analgesic request was 10.25 ± 2.09 hours.*

Conclusions: *Patient-controlled epidural analgesia using a bupivacaine-fentanyl mixture provides effective postoperative pain control in patients following renal transplantation.*

Keywords: PCEA, renal transplantation, postoperative analgesia.

Corresponding author: Tran Dac Tiep, Email: Trandactiepsky@gmail.com

Received: 3/9/2025; scientific review: 9/2025; accepted: 28/5/2026.

[1]*Military Hospital 103.*

[2]*Military Hospital 175.*

1. INTRODUCTION

In the final decades of the twentieth century, organ transplantation - particularly renal transplantation - achieved significant advances, substantially improving quality of life for patients with end-stage chronic renal failure. On December 23, 1954, Joseph Murray and John Merrill performed the first successful renal transplantation in Boston, marking a historic milestone in medicine. In Vietnam, the first living-donor renal transplantation was successfully performed in 1992 at Military Hospital 103, Vietnam Military Medical University [1]. To date, renal transplantation has been widely adopted and has become a routine surgical procedure at numerous medical institutions nationwide.

Postoperative care and management following renal transplantation are critical determinants of procedural success. Among these, adequate postoperative analgesia in renal transplant recipients warrants particular attention. Patient-controlled epidural analgesia (PCEA) is an effective analgesic modality that has been extensively employed in abdominal and obstetric surgery [2]. However, PCEA has been less frequently investigated in the context of renal transplantation, owing to concerns regarding coagulopathy in this patient population.

To contribute to the development of postoperative analgesic techniques for renal transplant recipients, we conducted this study to evaluate the analgesic efficacy of a bupivacaine-fentanyl mixture administered via patient-controlled epidural analgesia following renal transplantation.

2. SUBJECTS AND METHODS

2.1. Subjects

50 patients who underwent renal transplantation and received postoperative care

at Military Hospital 103 between March and November 2023.

Inclusion criteria: Patients who underwent renal transplantation and postoperative management at Military Hospital 103; patients with sufficient cognitive and behavioral capacity to understand and operate the PCA device; absence of contraindications to any of the study medications; provision of written informed consent.

Exclusion criteria: Patients with contraindications to epidural analgesia and/or those who developed serious perioperative or postoperative complications related to anesthesia or surgery.

2.2. Methods

- Study design: Retrospective, cross-sectional descriptive study.

- Sampling method: Convenience sampling.

- Procedural steps:

+ Step 1 (patient enrollment): Prior to surgery, the study investigator met with each patient to provide counseling regarding the PCEA technique, its benefits, and potential adverse effects. Patients who provided written informed consent were enrolled. A total of 50 patients meeting the inclusion criteria were included in the study.

+ Step 2 (general anesthesia and renal transplantation): Central venous access and invasive arterial blood pressure monitoring were established. An epidural catheter was placed at the L1-2, L2-3, or L3-4 interspace based on individual patient anatomy. A standardized anesthetic protocol was employed: induction with propofol 2–2.5 mg/kg, fentanyl 2 µg/kg, and rocuronium 1 mg/kg; endotracheal intubation and ventilation at a respiratory rate of 14 breaths/min with a tidal volume of 6-8 ml/kg; maintenance with sevoflurane and supplemental rocuronium as required. Perioperative medications included third-generation cephalosporin antibiotics, tranexamic acid 30 mg/kg, methylprednisolone sodium succinate (Solu-Medrol) 500 mg for immunosuppression, mannitol 1-2 ml/kg and furosemide 10-60 mg as diuretics. At the conclusion of surgery, neuromuscular blockade was reversed with sugammadex 2 mg/kg, and extubation was performed upon fulfillment of standard extubation criteria.

+ Step 3 (postoperative analgesia protocol): A Perfusor Space PCA pump was used, loaded with an analgesic solution comprising bupivacaine 0.1% and fentanyl 1 µg/ml. Pump settings were: bolus dose 3 ml, lockout interval 10 minutes, background infusion rate 3 ml/hour, and a 4-hour dose limit of 30 ml. All patients received an initial epidural loading dose (administered immediately following extubation), calculated according to individual patient height using the formula:

$$V = [\text{height (cm)} - 100]/10.$$

Dose titration was subsequently performed to achieve a VAS score < 4. If VAS ≥ 4, an additional 2 ml was administered and reassessment was performed after 3-5 minutes; PCEA was initiated once the VAS score was < 4.

+ Step 4 (data collection and analysis): Patients were monitored in the Post-Transplantation Intensive Care Unit. Data collected included: postoperative renal function, pain scores at rest and on movement, total bupivacaine and fentanyl consumption, number of PCEA demands and successful attempts, and time to first rescue analgesic request. Assessments were performed at the following time points from PCEA initiation (H0): 15 minutes (H0.25), 30 minutes (H0.5), 1 hour (H1), 4 hours (H4), 8 hours (H8), 16 hours (H16), 24 hours (H24), 36 hours (H36), 48 hours (H48), and 72 hours (H72). Pain intensity was assessed using the visual analog scale (VAS).

- Study outcome measures: Total analgesic drug consumption, loading dose volume, onset of analgesic effect, time to first rescue analgesic request, number of rescue analgesic requests and successful attempts, VAS scores at rest and on movement.

- Statistical analysis: Data were processed and analyzed using SPSS version 22.0. Continuous variables are expressed as mean ± standard deviation (± SD); categorical variables are presented as frequencies and percentages. An independent-samples t-test was used for between-group comparisons of continuous variables.

- Ethical considerations: The study was approved by the Research Protocol Review Committee of the Vietnam Military Medical University and the Biomedical Research Ethics Committee of Military Hospital 103 (Official Dispatch No. 256/HDDD dated August 9, 2023). Study data were reviewed and approved by the relevant department and the Postgraduate Training Office of the Vietnam Military Medical University. No conflicts of interest are declared. No additional costs were incurred by patients participating in the study.

3. RESULTS

Table 1. General characteristics of the study population

Characteristic	$\bar{X}$ ± SD (min-max)
Age	37,24 ± 12,13 (18-70)
Height (cm)	162,66 ± 7,99 (150-183)
Weight (kg)	53,86 ± 8,33 (40-79)
BMI (kg/m²)	20,25 ± 2,19 (15,6-25,7)

The mean age of the study patients was 37.24 ± 12.13 years. The mean body mass index (BMI) was 20.25 ± 2.19 kg/m².

Table 2. Total bupivacaine, fentanyl consumption

Characteristic	Bupivacain (mg)	Fentanyl (µg)
24 h (min-max)	125,4 ± 7,32 (110-141,2)	125,4 ± 7,32 (110-141,2)
48 h (min-max	78,3 ± 4,07 (72-87)	78,3 ± 4,07 (72-87)
72 h (min-max)	72,0 ± 0 (72)	72,0 ± 0 (72)

Mean doses of bupivacaine and fentanyl were highest on the first postoperative day and declined progressively on the second and third postoperative days.

Table 3. Loading dose volume, onset of analgesic effect, and time to first rescue analgesic request

Characteristic	$\bar{X}$ ± SD (min-max)
Loading dose volume (ml)	6,26 ± 0,79 (5-8,3)
Onset of analgesic effect (minutes)	10,64 ± 1,95 (7-13)
Time to first rescue analgesic request (hours)	10,25 ± 2,09 (7-13)

The mean loading dose volume was 6.26 ± 0.79 ml and the mean onset of analgesic effect was 10.64 ± 1.95 minutes. The mean time to first rescue analgesic request was 10.25 ± 2.09 hours.

Table 4. Number of PCEA demands and successful attempts

Characteristic	Time ($\bar{X}$ ± SD; min-max)			Total ($\bar{X}$ ± SD; min-max)
	H24	H48	H72	
PCEA demands (n)	15,36 ± 2,31 (10-19)	2,04 ± 1,30 (0-5)	0 (0-0)	17,4 ± 3,26 (11-24)
Successful PCEA attempts (n)	13,5 ± 2,1 (7-18)	1,5 ± 0,83 (0-4)	0 (0-0)	15,36 ± 2,67 (11-23)
A/D ratio (%)	88,04 ± 0,07 (70-100)	81,56 ± 25,3 (0-100)	0 (0-0)	86,76 ± 8,99 (65-100)

The highest number of PCEA demands was recorded on the first postoperative day (15.36 ± 2.31 attempts). The number of PCEA demands on day two was markedly lower than on day one, and no patient requested PCEA on day three. The A/D ratio was 88.04 ± 0.07% on day one and 81.56 ± 25.3% on day two.

Figure 1 demonstrates that VAS pain scores, both at rest and on movement, decreased progressively across postoperative time points.

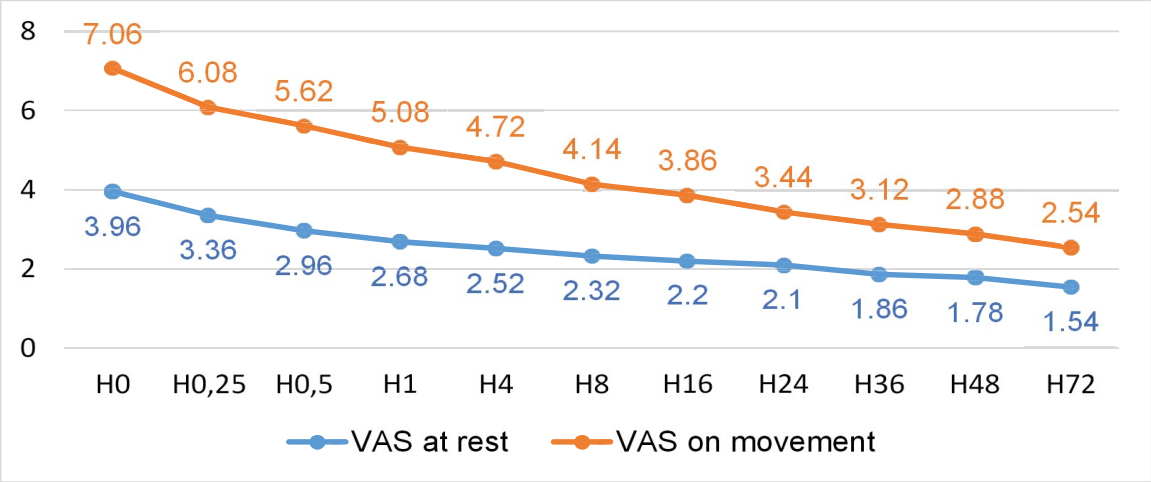

Figure 1. Mean VAS scores at rest and on movement (coughing) following surgery.

4. DISCUSSION

4.1. General characteristics of the study population

The mean age of the study cohort was 37.24 ± 12.13 years, consistent with findings reported by Hoang Anh Trung et al. (2024) in a study of 123 renal transplant patients at Military Hospital 103 (41.93 ± 11.42 years) [3]. Multiple studies have demonstrated that patient age influences postoperative analgesic requirements: age-related changes in epidural space anatomy and neuroreceptor sensitivity result in younger patients requiring higher analgesic doses compared to elderly patients.

The mean BMI of the study population was 20.25 ± 2.19 kg/m², comparable to values reported in other clinical trials involving renal transplant recipients. In a study by Shaopeng Ming (2024), the mean BMI of 320 renal transplant recipients was 22.2 kg/m². The consensus among investigators is that maintaining a BMI between 22.0 and 25.5 kg/m² in renal transplant recipients is associated with improved early renal graft recovery.

4.2. Total bupivacaine and fentanyl consumption

Total bupivacaine consumption over the first three postoperative days was 125.4 ± 7.32 mg, 78.3 ± 4.07 mg, and 72.0 ± 0.00 mg, respectively. The declining pattern of bupivacaine consumption reflects the attenuation of postoperative nociceptive stimulation, resulting in fewer patient-initiated supplemental bolus requests. These findings are consistent with those of Nguyen Trung Kien (111.9 ± 5.7 mg, 102.4 ± 5.1 mg, and 94.2 ± 2.1 mg over the first three postoperative days) [4]. Compared with the data reported by Nguyen Hong Thuy in patients undergoing nephroureterectomy (197.02 ± 16.77 mg on day one; 183.34 ± 14.62 mg on day two) [5], our values were lower, possibly because our study population comprised patients with end-stage chronic kidney disease who may have inherently lower analgesic requirements. Daily fentanyl consumption over the first three postoperative days decreased from 125.4 ± 7.32 µg on day one to 78.3 ± 4.07 µg on day two and 72.0 ± 0.00 µg on day three. Peak fentanyl consumption occurred during the first postoperative day, corresponding to the highest analgesic demand. Fentanyl dosing is also influenced by the selected concentration; in this study, a fentanyl concentration of 1 µg/ml was used. Other investigators have employed a concentration of 2 µg/ml to achieve superior analgesic efficacy, accepting a higher risk of adverse effects such as nausea, respiratory depression, or motor blockade.

4.3. Postoperative analgesic efficacy

The mean loading dose volume was 6.26 ± 0.79 ml, consistent with the recommendation by Visser W et al. (1998) that 1-1.5 ml of local anesthetic per spinal segment is required for adequate sensory blockade, and that the optimal epidural catheter insertion depth is 4-6 cm. Kim YJ et al. (2021), in a study of epidural catheters for analgesia after upper abdominal surgery, similarly concluded that an initial loading dose exceeding 5 ml prior to PCEA initiation effectively increases the extent of sensory blockade.

When calculating the epidural loading dose volume, patient age and height may be used as guiding parameters. It is important to note that the epidural space tends to narrow with advancing age due to intervertebral disc degeneration, fibrotic tissue proliferation, foraminal stenosis, and arterial sclerosis. These changes predispose elderly patients to a wider spread of local anesthetic within the epidural space. In this study, loading dose volume was calculated based on patient height. The mean onset of analgesic effect was 10.64 ± 1.95 minutes. A study by Tran Thanh Huong et al. (2011) on epidural analgesia in parturients [6] reported mean analgesic onset times of 11 minutes in group 1 and 11.06 minutes in group 2, consistent with our findings. Our onset time was longer than that reported by Nguyen Trung Kien (3.0 ± 0.8 minutes) [4], which may be attributed to the older patient cohort in the latter study, as elderly patients tend to exhibit greater sensitivity to local anesthetics and opioids. The mean time to first rescue analgesic request was 10.25 ± 2.09 hours; the earliest rescue request occurred at 7 hours postoperatively. A study by Tohamy et al. (2021), evaluating postoperative epidural analgesia in patients undergoing lower abdominal cancer surgery, reported a mean time to rescue analgesia of 10.20 ± 1.42 hours in group II [7], which is comparable to our findings.

4.4. PCEA-related parameters

The PCA pump was programmed with a demand dose of 3 ml, a background infusion rate of 3 ml/hour, a lockout interval of 10 minutes, and a 4-hour dose limit of 30 ml. Rescue analgesia consisted of 5 ml of lidocaine 1% for all patients. If pain persisted 15 minutes after rescue analgesia, continuous intravenous fentanyl infusion at 10 µg/ml (2-3 ml/hour) was initiated.

The mean total number of PCEA demands in this study was 17.4 ± 3.26. These results are consistent with those reported by Tran Hoai Nam et al. in patients undergoing open abdominal surgery (18.2 ± 0.8 demands) [8] and Karis Bin

Misiran (2013), who evaluated analgesia following total knee arthroplasty (total demands: 27.66 ± 9.12; successful attempts: 22.37 ± 7.32) [9]. The higher demand counts reported by these authors compared to ours may reflect differences in study populations and PCA programming parameters, as those investigators used a background infusion rate of 2 ml/hour compared to 3 ml/hour in our study. The overall A/D ratio in our study was 86.76 ± 8.99%. Most domestic studies report A/D ratios in the range of 70–90% [8]. The high A/D ratio may be partly attributed to the addition of fentanyl or another opioid, which accelerates the onset of analgesia and increases the likelihood of a successful PCEA response. Furthermore, appropriate individualization of PCA pump parameters is instrumental in optimizing the A/D ratio and enhancing patient satisfaction.

4.5. VAS scores at postoperative time points

At baseline (H0), the mean resting VAS score was 3.96 ± 0.49. Following drug administration, VAS scores declined progressively (from 3.96 ± 0.49 at H0 to 3.36 ± 0.59 at H0.25 and 1.54 ± 0.78 at H72; $p < 0.05$). VAS scores on movement (during coughing) reached the target threshold after 16 hours (decreasing from 7.06 ± 0.68 at H0 to 3.86 ± 1.14 at H16). Mean VAS scores at all postoperative assessment time points were lower than baseline values, both at rest and on movement. These findings are consistent with those of multiple domestic and international investigators. Mann C (2000) compared the analgesic efficacy of PCEA and intravenous PCA (IV-PCA) following abdominal surgery in elderly patients, and found that while both modalities provided effective analgesia, PCEA yielded superior pain control with lower VAS scores at rest and during coughing compared to IV-PCA. In a study by Jan Maca (2020) comparing PCEA versus continuous epidural infusion following total hip arthroplasty, VAS scores in the PCEA group were significantly lower than those in the non-PCEA group at 6, 10, and 23 hours postoperatively ($p < 0.05$) [10]. In Vietnam, Do Trung Dung (2018) compared lumbar plexus block with epidural anesthesia for lower limb surgery, and reported that resting VAS scores in the epidural group decreased from 4.02 ± 0.15 at baseline to 0.53 ± 0.76 at 24 hours postoperatively ($p < 0.05$); VAS scores on movement declined from 4.44 ± 1.2 to 1.4 ± 1.3. The lower baseline VAS scores on movement compared to our study may be attributable to residual sensory blockade from spinal anesthesia at the end of lower limb surgery. Nguyen Trung Kien reported mean resting VAS scores at H0 of 4.6 ± 0.6 and 4.7 ± 0.5 in the PCEA and IV-PCA groups, respectively. VAS scores in both groups declined rapidly following drug administration; at H0.25, the PCEA group had a VAS score of 1.1 ± 0.6 compared with 2.2 ± 0.5 in the IV-PCA group. VAS scores during coughing also decreased substantially from H0 in both groups (PCEA: 6.3 ± 0.5 to 2.5 ± 0.7; IV-PCA: 6.4 ± 0.6 to 3.4 ± 0.6 at H0.25). The author concluded that mean VAS scores, both at rest and during coughing, were statistically significantly lower in the PCEA group compared to the IV-PCA group [5].

Limitations: The study was limited by a small sample size (n = 50), which may affect the representativeness and generalizability of the findings. The absence of a control group precluded direct comparison with alternative analgesic modalities. The study follow-up period was restricted to the early postoperative phase, without long-term assessment of postoperative complications or potential delayed adverse effects of PCEA. A longer follow-up study would be valuable in elucidating long-term consequences, including effects on renal allograft function.

5. CONCLUSIONS

This study evaluated patient-controlled epidural analgesia over the first 72 postoperative hours in 50 renal transplant recipients using a combination of bupivacaine 0.1% and fentanyl 1 µg/ml. The results demonstrate that this analgesic modality provides effective postoperative pain control. At 72 hours postoperatively, mean VAS pain scores at rest and on movement were 1.54 ± 0.78 and 2.54 ± 0.76, respectively, both significantly lower than baseline values

REFERENCES

1. David H. Kidney transplantation: a history. Kidney transplantation: Principle and practice, 1-9, 2014.
2. Liu S.S, Allen H.W, Olsson G.L, “Patient-controlled epidural analgesia with bupivacaine and fentanyl on hospital wards: prospective experience with 1,030 surgical patients”, Anesthesiology, 88(3), 688-695, 1998.
3. Hoang Anh Trung, Hoang Thi Mien, Mai Thi Hien et al., “Association between anemia and clinical characteristics in post-renal transplant patients at Military Hospital 103”, Journal of Military Medicine and Pharmacy, 49 (5), 172-181, 2024.
4. Nguyen Trung Kien, Efficacy of patient-controlled thoracic epidural analgesia using bupivacaine-fentanyl mixture following upper abdominal surgery in elderly patients. Doctoral

dissertation, 108 Institute of Clinical Medical and Pharmaceutical Sciences, 2014.

5. Nguyen Hong Thuy, Postoperative analgesic efficacy of continuous ultrasound-guided thoracic paravertebral block using bupivacaine-sufentanil mixture in patients undergoing nephroureterectomy. Doctoral dissertation, Hanoi Medical University, 2018.

6. Tran Thanh Huong, Nguyen Thi Minh Yen, Nguyen Thanh Tu, Evaluation of analgesic efficacy of epidural bupivacaine combined with fentanyl in laboring women. Journal of Practical Medicine, 5(765), 56-58, 2011.

7. Moaaz M.T, Samy A., Asraf A.M, et al., Effect of Bilateral Ultrasound-Guided Quadratus Lumborum Block versus Lumbar Epidural Block on Postoperative Analgesia following Major Lower Abdominal Cancer Surgery, 11 (12), 335-346, 2021.

8. Tran Hoai Nam, Hoang Van Chuong, "Evaluation of analgesic efficacy of thoracic epidural analgesia using ropivacaine combined with fentanyl via patient-controlled administration following abdominal surgery", Vietnam Medical Journal, 502 (2), 17-30, 2021.

9. Misiran K.B., Yahaya L.S.B, "The effectiveness of patient- controlled epidural analgesia with ropivacaine 0.165% with fentanyl 2.0 micro g/ml or levobupivacain 0.125% with fentanyl 2.0 micro g/ml as a method of postoperative analgesia after major orthopedic surgery", Middle East J Anaesthesiol, 22 (1), 59-64, 2013.

10. Maca J., Neiser J., Grasslova L., et al., "Patient-controlled epidural analgesia versus conventional epidural analgesia after total hip replacement - a randomized trial", Biomedical papers of the Medical Faculty of the University Palacky, Olomouc, Czechoslovakia, 164 (1), 108-114, 2020. ❑