Evaluation of the Effectiveness of Patient-Controlled Epidural Analgesia in Operative Gynecology in Patients with Heart Failure

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Abstract

Objective: To evaluate the clinical efficacy of patient-controlled epidural analgesia (PCEA) in women with chronic heart failure (CHF) undergoing hysterectomy.

Materials and Methods: A prospective randomized study included 40 female patients aged 65–80 years, ASA class III–IV, diagnosed with CHF. Patients were divided into two groups: the control group (n=21) received conventional opioid analgesics as needed, while the study group (n=19) received PCEA with longocaine. Hemodynamic parameters, pain intensity (VAS), cortisol and glucose levels, and incidence of adverse events were assessed.

Results: The PCEA group demonstrated significantly lower pain scores, more stable hemodynamic parameters, and statistically significant reductions in cortisol and glucose levels compared to the control group. The incidence of adverse effects was also lower in the PCEA group.

Conclusion: PCEA is a safe and effective method for postoperative pain management in gynecological patients with chronic heart failure, providing individualized pain control, hemodynamic stability, and improved postoperative recovery.

Keywords: epidural analgesia, patient-controlled analgesia, hysterectomy, heart failure, postoperative pain.

Introduction:

One of the key challenges in the early postoperative period of gynecological surgery in patients with heart failure (HF) remains inadequate pain management. This is most often due to the routine use of opioid analgesics administered on a fixed schedule or "as needed," whose effectiveness is frequently insufficient. Clinical observations show that such regimens fail to provide adequate analgesia for a significant number of patients with chronic heart failure (CHF), particularly after extensive surgical interventions [1, 2].

A modern approach to postoperative pain management in gynecological patients with CHF requires not only pain relief as a symptom but also the creation of psychological comfort, improvement of quality of life, acceleration of functional rehabilitation, and reduction of postoperative complications [3]. According to international studies, severe postoperative pain is reported in 30–75% of patients, underscoring the clinical importance of the issue [4, 5].

In this context, increasing attention is being paid to the development and implementation of personalized methods of analgesic delivery that consider individual

patient characteristics. One such method is patient-controlled analgesia (PCA) — a modern, technologically advanced system that allows the patient to self-administer analgesics through a specially programmed infusion pump (syringe or perfusion type). This method transfers partial control of analgesic administration to the patient, within safe limits predefined by the physician for dosage, time intervals, and total daily load.

This approach enables the patient to respond promptly to the onset or increase of pain after major gynecological surgeries without waiting for medical staff intervention. The system provides for an individual bolus dose with a preset *lockout interval* that prevents overdose. An additional advantage of PCA is the development of a sense of control over one's condition, which reduces anxiety and increases overall satisfaction with therapy. Moreover, the ability to self-regulate dosing significantly decreases the total daily need for analgesics, particularly opioids, thereby reducing the risk of overdose and associated complications.

Multidisciplinary studies have demonstrated that the use of PCA significantly reduces pain intensity during the first 24 hours after surgery and decreases the incidence of side effects such as nausea, excessive sedation, and urinary retention, making this method preferable in modern postoperative pain management.

Thus, PCA is not merely a drug delivery method but a philosophy of personalized analgesia, combining principles of pharmacology, pain physiology, psychology, and modern technology. It should be considered an effective and rational alternative to traditional analgesic regimens, especially in modern gynecological, abdominal, and trauma surgery.

Given the above, the aim of the present study was to clinically evaluate the efficacy of patient-controlled epidural analgesia (PCEA) for postoperative pain management in women undergoing hysterectomy.

Materials and Methods:

This prospective randomized study was conducted at the Department of Gynecology, Tashkent Medical Academy Clinic. The study included **40 female patients aged 65 to 80 years** (mean age 76.4 ± 7.5 years), classified as **ASA physical status class III–IV**, who were scheduled for **hysterectomy due to uterine fibroids**. All patients were hospitalized, and preoperative preparation, surgical intervention, and postoperative management were performed according to standardized clinical protocols. A **total hysterectomy** was performed in 22 patients and a **subtotal hysterectomy** in 18 patients.

All patients were divided into **two comparable groups** matched by age, somatic status, and surgery duration.

- **Group I (n = 21)** received conventional postoperative analgesia using opioid analgesics administered on demand.
- **Group II (n = 19)** received **patient-controlled epidural analgesia (PCEA)** using the *Accumate-1100 Electronic PCA* device. In this group, **5 mL of**

0.25% longocaine solution was administered via the epidural catheter every 4 hours, and additional bolus doses could be self-administered by the patient using the handheld control unit. The duration of PCEA was **24 hours post-surgery**.

The **degree of motor blockade** was assessed using the **Bromage scale**, and **pain intensity** was evaluated using the **10-point Visual Analogue Scale (VAS)**. Additionally, central hemodynamic parameters were recorded, including **heart rate (HR)**, **systolic arterial pressure (SAP)**, **respiratory rate (RR)**, and **oxygen saturation (SpO_2)**. **Stress hormone levels**, such as **plasma cortisol** and **glucose concentrations**, were also measured.

All parameters were assessed at **three observation points**:

1. Baseline (before analgesic administration),
2. 20 minutes after the first analgesic dose,
3. 24 hours after surgery.

All quantitative data obtained during the study were processed using **methods of variation statistics** with **Student's t-test**. Statistical analysis was carried out using standard software packages. Results were expressed as **mean (M) ± standard error of the mean (m)**. Differences between groups were considered statistically significant at **$p < 0.05$**.

Results and Discussion

Before the initiation of postoperative analgesia, hemodynamic and respiratory parameters in both groups were comparable, with no statistically significant differences. At the first observation stage (before analgesic administration), all patients reported severe pain (average VAS score > 7), accompanied by tachycardia, moderate arterial hypertension, and increased respiratory rate — a typical picture of a systemic stress response.

In the control group (n = 21), which received parenteral opioid analgesics on demand, a moderate reduction in pain was observed; however, pain intensity remained in the range of 3.5–4.0 VAS points, indicating incomplete pain control and the need for repeated doses. Several adverse effects were recorded:

- Hypotension — in 2 patients;
- Decreased oxygen saturation — in 3 patients;
- Bradypnea — in 1 case;
- Nausea and vomiting — in 6 patients (≈30%), predominantly among those over 80 years old.

In the study group (n = 19), where patient-controlled epidural analgesia (PCEA) was administered using the *"Accumate-1100"* device, the analgesic effect was significantly greater. Within the first postoperative hour, pain intensity decreased to 1.5 VAS points, and no severe pain was reported throughout the observation period. A mild motor block (1–2 points on the Bromage scale) was observed in only 3 patients and was short-term and fully reversible.

Patients quickly adapted to self-control and independently extended intervals between boluses, allowing for optimal pain management without additional medical intervention.

Adverse effects in the PCEA group were infrequent:

- Arterial hypotension — 2 cases;
- Acute urinary retention — 1 case;
- Post-puncture syndrome — 2 cases.

No infectious or severe neuroaxial complications were observed.

Thus, epidural analgesia under patient control demonstrated high efficacy and a favorable safety profile, maintaining an optimal balance between analgesia and hemodynamic stability.

Table 1

Hemodynamic, respiratory, and pain parameters in operated women

Parameters	Control Group			PCEA Group		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
SBP, mmHg	128.5 ± 5.7	119.5 ± 5.4	120.5 ± 5.2	126.7 ± 5.2	123.5 ± 5.7	121.5 ± 5.3
DBP, mmHg	85.6 ± 5.3	81.6 ± 5.1	81.4 ± 5.3	84.5 ± 5.1	84.1 ± 5.3	83.1 ± 5.1
HR, bpm	86.8 ± 7.4	78.8 ± 7.4	73.8 ± 3.4	85.8 ± 8.0	74.8 ± 7.4	71.8 ± 4.4
RR, per min	18.6 ± 2.4	14.6 ± 2.4	14.6 ± 2.4	18.5 ± 2.6	16.6 ± 2.5	15.6 ± 2.5
SpO_2, %	98.3 ± 1.5	96.3 ± 1.5	97.3 ± 1.5	98.1 ± 1.7	98.3 ± 1.8	99.3 ± 0.6
VAS, points	7.4 ± 1.3	3.6 ± 1.8	3.5 ± 1.5	7.2 ± 1.9	1.5 ± 0.5	1.2 ± 0.2
Cortisol, nmol/L	186.1 ± 51.1	184.5 ± 49.1	178.1 ± 43.1	186.2 ± 52.1	149 ± 43.1	145.3 ± 32.1
Glucose, mmol/L	6.1 ± 1.3	4.26 ± 0.4	4.3 ± 0.3	6.2 ± 1.5	4.09 ± 0.3	4.04 ± 0.1

In both groups, blood pressure and heart rate tended to normalize after analgesia; however, in the PCEA group, hemodynamic parameters remained more stable, with no signs of cardiac depression or systemic suppression.

As shown in Table 1, the cortisol level in the PCEA group decreased significantly ($p < 0.05$), indicating effective suppression of the hypothalamic-pituitary-adrenal

(HPA) axis stress response. This dynamic reflects adequate nociceptive blockade, preventing excessive stress hormone release into the systemic circulation.

Glycemic levels also decreased under PCEA (from 6.2 to 4.04 mmol/L), whereas in the control group glucose values fluctuated within a wider range. This stabilization may indicate reduced activation of the endocrine stress component.

The onset of analgesia in the PCEA group occurred 20–30 minutes faster than in the traditional method due to the absence of delays associated with drug preparation or physician approval. Furthermore, initiating PCEA early (during mild to moderate pain) yielded a more pronounced clinical benefit: analgesic efficacy reached 95%, while delayed initiation during intense pain resulted in insufficient pain relief in 15% of patients. In conclusion, patient-controlled epidural analgesia (PCEA) provides high clinical efficacy, hemodynamic stability, and suppression of stress-related hormonal responses, making it a superior and personalized method of postoperative pain control in gynecological patients with chronic heart failure.

Conclusions

1. **Patient-controlled epidural analgesia (PCEA)** in gynecological patients provides more effective and individualized postoperative pain relief compared to traditional methods, significantly reducing pain intensity.
2. The use of PCEA promotes **hemodynamic stability**, reduces **stress indicators** (cortisol and glucose levels), and minimizes the risk of adverse effects, especially in elderly patients with comorbid conditions.
3. The application of **low concentrations of local anesthetics** helps preserve motor function and facilitates **early rehabilitation** of patients after hysterectomy.
4. PCEA is an **effective and safe method** that should be considered the **preferred approach to postoperative analgesia** in gynecological surgery.

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