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Etomidate combined with TAPB in ovarian cancer surgery: A controlled study on hemodynamics and immune response

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Abstract: **Background**: Selecting appropriate anesthetic agents and techniques that ensure hemodynamic stability and attenuate perioperative stress responses is crucial for ovarian cancer surgery. **Objectives**: This study aimed to evaluate the effects of etomidate combined with transversus abdominis plane block (TAPB) on perioperative hemodynamics, inflammatory and oxidative stress responses and immune function in patients undergoing radical resection of ovarian cancer. **Methods**: A total of 80 patients were randomly assigned to receive total intravenous anesthesia (TIVA) alone or TIVA combined with TAPB. Hemodynamic parameters, serum inflammatory markers, oxidative stress indicators, pain mediators, immune cell subsets and adverse reactions were compared between the two groups. **Results**: Perioperative hemodynamic parameters changed dynamically in both groups, with heart rate and mean arterial pressure increasing intraoperatively and decreasing postoperatively. However, the research group had significantly lower heart rate and mean arterial pressure than the control group during the peak intraoperative period ($P<0.001$), indicating improved hemodynamic stability. Preoperative levels of inflammatory, oxidative stress, pain-related and immune indexes were comparable between groups ($P>0.05$). At 24 h postoperatively, the research group showed significantly reduced serum levels of high-sensitivity C-reactive protein, tumor necrosis factor-α, malondialdehyde, cortisol, prostaglandin E2 and substance P compared with the control group (all $P<0.05$), reflecting attenuation of systemic inflammation, oxidative stress and nociceptive activation. Postoperative immune function was better preserved in the research group, as evidenced by higher CD3+ and CD4+ cell counts and CD4+/CD8+ ratio, along with a lower CD8+ level ($P<0.05$). The overall incidence of adverse reactions was low and did not differ significantly between groups (4.4% vs 8.9%, $P>0.05$). **Conclusion**: Etomidate combined with transversus abdominis plane block provides stable anesthesia and modulates perioperative inflammatory and immune responses while reducing postoperative biochemical pain mediator levels, thereby supporting a safer and more physiologically balanced recovery following ovarian cancer surgery.

Keywords: Etomidate; Immune function; Ovarian cancer; Resection

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INTRODUCTION

Ovarian cancer remains one of the most lethal gynecologic malignancies and radical resection is the primary treatment to achieve optimal cytoreduction and prolong survival (Yokoi *et al*., 2024). However, this surgery is highly invasive and often leads to pronounced hemodynamic fluctuations, inflammatory activation and postoperative pain, all of which may adversely affect recovery (Maeda *et al*., 2022; Liu *et al*., 2020). Selecting appropriate anesthetic agents and techniques that ensure hemodynamic stability and attenuate perioperative stress responses is therefore of great clinical importance.

Total intravenous anesthesia (TIVA) is widely used in gynecologic oncology because it allows precise control of anesthetic depth and stable induction (Ramirez and Gan, 2023). Etomidate, a commonly used imidazole derivative, provides smooth induction with minimal cardiovascular depression and is frequently applied during radical surgery. Nevertheless, TIVA alone may not adequately suppress sympathetic activation and patients can still experience significant intraoperative stress and immune suppression (Ramirez and Gan, 2023; Zhi and Li, 2023). To improve perioperative stability, multimodal anesthesia strategies combining regional blocks with general anesthesia have gained increasing attention. The transversus abdominis plane block (TAPB) can effectively block somatic pain transmission from the anterior abdominal wall, thereby reducing postoperative pain and systemic stress (Prabhakar *et al*., 2023).

The perioperative period represents a critical window during which anesthetic strategies can modulate immune function and tumor biology, potentially influencing both immediate recovery and tolerance to adjuvant therapy. Recent studies suggest that anesthetic agents may differentially affect immune and inflammatory pathways through their impact on cytokine balance, oxidative stress and immune surveillance (Cai *et al*., 2023). Compared to volatile agents and opioids, which may impair immune function, etomidate appears relatively immune-preserving (Manav *et al*., 2024). Regional anesthesia techniques such as TAPB further mitigate systemic inflammation and stress, potentially supporting a more favorable perioperative immune environment.

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Despite these insights, evidence remains limited regarding how etomidate combined with TAPB influences perioperative immune and inflammatory homeostasis in patients with ovarian cancer. Therefore, this study aimed to evaluate the effects of etomidate combined with TAPB on perioperative hemodynamics, inflammatory and immune responses and oxidative stress in patients undergoing radical resection of ovarian cancer. By clarifying this anesthetic immunological interplay, the findings may provide a theoretical basis for optimizing multimodal anesthesia strategies that stabilize perioperative physiology and support postoperative recovery in gynecologic oncology.

MATERIALS AND METHODS

Trial registration

This trial was registered retrospectively on 08/05/2026 with registry number ISRCTN10813814. The first participant was enrolled on 01/09/2022. Ethical approval was obtained on 03/09/2022.

Sample size and power analysis

The sample size was estimated based on the formula for comparing two independent means: $n = 2(Z_{\alpha/2}+Z_{\beta})^2\sigma^2/\delta^2$, where $Z_{\alpha/2}=1.96$ (two-tailed $\alpha = 0.05$), $Z_{\beta}=0.84$ (80% power), σ represents the standard deviation and δ represents the expected mean difference. According to previous studies on perioperative inflammation in gynecologic surgery (Xu *et al*., 2021), the postoperative serum TNF-α level differed by approximately 8 pg/mL between groups, with a standard deviation of about 10 pg/mL (Cohen's d≈0.8). Substituting these values yielded 25 participants per group. Accounting for possible dropouts, the sample size was increased by 20%, resulting in a minimum of 30 participants per group. In this study, 45 patients were enrolled in each group, exceeding the required sample size and ensuring adequate statistical power.

Collection of general data

Patients (90 in total) treated with radical resection of ovarian cancer in the hospital between September 2023 and September 2024 were grouped in a randomized controlled manner. The general data were comparable between control group (n=45) and research group (n=45) (P>0.05) (Table 1).

Inclusion and exclusion criteria

Inclusion criteria involved: 1) patients definitely diagnosed with ovarian cancer through biopsy, 2) those with complete clinical data, 3) those with normal cognitive function, communication ability, vision and hearing, 4) those presenting the indications of radical resection of ovarian cancer and 5) those with American Society of Anesthesiologists (ASA) grade I-III ovarian cancer. *Exclusion criteria were adopted*: 1) patients complicated with other malignant tumors, 2) those with hematologic diseases, 3) those with abnormal immune function, 4) those with severe dysfunction of the heart, liver, lung, kidney or other organs, 5) pregnant or lactating women, 6) those with coagulation abnormalities or bleeding tendency, or 6) those with contraindications to anesthesia.

Anesthesia methods

The patients in both groups were routinely deprived of food and water before operation and then they were connected with anesthesia monitors and non-invasive cardiac function monitors for routine monitoring after entering the operating room. TIVA plus etomidate were provided for the control group. For anesthesia induction, the mixed solution of 0.05 mg/kg midazolam injection (Jiangsu Nhwa Pharmaceutical Co., Ltd., China, strength: 2 mL: 10 mg), 2 mg/kg propofol medium and long chain fat emulsion injection (Jiangsu Nhwa Pharmaceutical Co., Ltd., China, strength: 20 mL: 200 mg), 0.4 μg/kg sufentanil citrate injection (Yichang Renfu Pharmaceutical Industry, China, strength: 1 ml: 50 μg) and 0.6 mg/kg rocuronium bromide injection (Shanghai Haini Pharmaceutical Co., Ltd., China, strength: 5 ml: 50 mg) was intravenously injected, after which tracheal intubation was performed through mouth for mechanical ventilation. Next, 2-3 mg/(kg·h) propofol medium and long chain fat emulsion injection and 0.2-0.4 mg/(kg·h) etomidate injectable emulsion (Forry) (Jiangsu Nhwa Pharmaceutical Co. Ltd., China, strength: 10 mL: 20 mg) were administered by target-controlled infusion to maintain anesthesia and 0.15 mg/kg rocuronium bromide injection was given every 40 min. During operation, the drug dosage was adjusted in real time based on patients' bispectral index and respiratory frequency index and the former was maintained at 40-60. Finally, the drug infusion was stopped at 5 min before the end of operation.

The research group underwent TIVA with etomidate + TAPB. TIVA was conducted in the same way as that in control group. Subsequently, with the patients in the supine position, a 13-16 MHz linear array ultrasonic probe (V6-2, Philips) was placed on the lateral abdominal wall between the iliac crest and the costal margin, which was slowly moved until the external abdominal oblique muscle, internal abdominal oblique muscle, transversus abdominis and different layers in the abdominal cavity were clearly displayed on the video. Ultrasound-guided puncture was performed (position: at the level of the midaxillary line between the costal margin and the iliac crest). After successful puncture (the puncture needle was inserted into the transversus abdominis plane), with no gas or blood determined, 20 mL of 0.5% ropivacaine hydrochloride injection (Guangdong Jiabo Pharmaceutical Co., Ltd., China, strength: 10 mL: 100 mg) was injected into the transversalis fascia layer, followed by observation of drug diffusion and penetration. The plane block was accomplished when fusiform-shaped echoless diffusion of ultrasound signals appeared and then the nerve block on the contralateral side was implemented using the same maneuver.

Evaluation of observation indexes

Hemodynamics: Mean arterial pressure (MAP) and heart rate (HR) of the patients were measured at different time points [5 min before anesthesia (T_0), 5 min after anesthesia (T_1), at the time of tracheal intubation (T_2), 10 min after tracheal intubation (T_3) and immediately after the end of operation (T_4)].

Serum-related factors: Fasting venous blood (3-5 mL) was separately collected from the patients before operation and at 24 h after operation and then centrifuged to obtain the serum. Afterward, the levels of high-sensitivity C-reactive protein (hs-CRP) and tumor necrosis factor (TNF-α), concentrations of malondialdehyde (MDA) and cortisol (Cor) and content of prostaglandin E2 (PGE2) and substance P (SP) were determined through chemiluminescence immunoassay, chemical colorimetry and enzyme-linked immunosorbent assay, respectively. Among them, hs-CRP and TNF-α are inflammatory markers, while MDA and Cor are oxidative stress markers and PGE2 and SP are pain mediator markers. In this study, only biochemical markers (PGE2 and SP) were used to reflect pain-related stress responses; no subjective pain assessment tools such as the Visual Analog Scale (VAS) or Numeric Rating Scale (NRS) were collected.

Immune function indexes: Fasting venous blood in a volume of 3-5 mL was collected from the patients before operation and at 24 h after operation. Then a flow cytometer (CytoFLEX, Beckman Coulter) was employed to detect the levels of T lymphocytes [cluster of differentiation CD3+] and T-lymphocyte subsets (CD4+ and CD8+) and the CD4+/CD8+ ratio was calculated.

Incidence rate of adverse events: The adverse events mainly included pruritus, nausea & vomiting, bradycardia, dizziness & headache, respiratory depression, lethargy and delirium.

Statistical analysis

SPSS 23.0 software was used for statistical analysis. The measurement data were described by ($\bar{x} \pm s$). In the case of homogeneity of variance, the independent-samples *t*-test was conducted for intergroup comparison and the paired-samples *t*-test was adopted for intragroup comparison. Regarding heterogeneity of variance, the corrected *t*-test (*t*' test) was performed and repeated-measures analysis of variance was used for multiple time points between groups. Count data were presented as [n (%)] and examined by the χ^2 test. $P<0.05$ suggested a difference of statistical significance. Effect sizes (Cohen's d) and 95% confidence intervals (95% CI) were calculated to quantify the magnitude and precision of intergroup differences. Statistical significance was set at $P < 0.05$. No formal correction for multiple comparisons was applied, as all measured parameters were predefined endpoints with specific physiological relevance rather than post hoc exploratory variables.

RESULTS

Hemodynamic indexes

HR and MAP were elevated at T1 and T2 in both groups compared with T0 and then gradually decreased at T3 and T4 relative to T2. At T2, the control group exhibited higher HR and MAP than the research group, with mean differences of 5.9 bpm (95% CI 2.0-9.7, d=0.61) and 8.5 mmHg (95% CI 3.7-13.3, d=0.67; $P<0.001$), respectively. Significant differences were observed between groups, across time points and for intergroup–time interactions ($P<0.05$) (Table 2).

Serum-related factors

There were no significant differences in the levels of serum hs-CRP and TNF-α between research group and control group before operation ($P>0.05$). At 24 h post-operation, hs-CRP and TNF-α were markedly lower in the research group than in the control group, the corresponding mean differences were 9.79 mg/L (95% CI 9.34-10.24, d=9.60) and 33.58 pg/mL (95% CI 30.17-36.99, d=4.34; $P<0.001$). These reductions indicate a clinically meaningful attenuation of systemic inflammation, which is often associated with faster postoperative recovery and reduced surgical stress (Table 3).

Oxidative stress indexes

The preoperative serum MDA and Cor levels were not significantly different between research group and control group ($P>0.05$). At 24 h after surgery, both indicators were substantially reduced in the research group compared with the control group, the mean differences were 2.65 nmol/mL (95% CI 2.45-2.85, d=6.18) and 85.10 nmol/L (95% CI 70.6-99.6, d=2.53; $P<0.001$). The marked decline in MDA and Cor suggests decreased oxidative and endocrine stress, reflecting improved physiological stability during the perioperative period (Table 4).

Pain mediator indexes

The serum PGE2 and SP levels exhibited no significant difference between research group and control group prior to operation ($P>0.05$). At 24 h after operation, the two indexes were decreased in research group in comparison to those in control group ($P<0.05$). The lower postoperative PGE_2 and SP levels in the research group imply effective suppression of pain-related neurohumoral activation, consistent with better postoperative comfort and reduced nociceptive stress. (Table 5).

Immune function indexes

The differences in preoperative CD4+ and CD3+ levels as well as CD4+/CD8+ ratio were not significantly different between research group and control group ($P>0.05$). At 24 h post-operation, these immune indicators (CD4+, CD3+ and CD4+/CD8+ ratio) were significantly higher in the research group than in the control group, whereas CD8+ was significantly lower indicating better preservation of immune function. These findings demonstrate preserved

immune function and attenuated perioperative immunosuppression in patients receiving etomidate plus TAPB (Table 6).

Incidence rate of adverse reactions

The incidence of adverse reactions was low in both groups, with no statistically significant difference (4.4% vs 8.9%, -4.5 percentage points, 95% CI 14.7-5.8, P=0.673). Reported events included nausea and vomiting (2.2%), dizziness and headache (2.2%) and bradycardia (2.2%), all of which were mild and resolved without intervention (Table 7).

DISCUSSION

Radical resection of ovarian cancer can effectively remove the lesion and prolong the survival of patients (Caruso *et al*., 2025). However, such an operation is highly traumatic, during which the traumatic manipulations can cause violent hemodynamic fluctuations, not only increasing the risk of the operation but being detrimental to the postoperative recovery of patients. Hence, selecting an appropriate intraoperative anesthetics and anesthetic methods is of extremely important significance.

TIVA refers to a technique for realizing the induction and maintenance of anesthesia *via* multiple intravenous anesthetics. In this anesthesia protocol, the infusion rate can be calculated and controlled by virtue of a computerized target-controlled automatic intravenous infusion system, so as to automatically achieve the expected target (sedative or analgesic) concentration, which is a commonly used anesthesia protocol in radical resection of ovarian cancer (Fu *et al*., 2025; Liang *et al*., 2024). As a type of imidazole derivative, etomidate possesses a central sedative effect, which can exert the anesthetic effect by acting on γ-aminobutyric acid A receptor after administration, without repressing the tension of sympathetic nerve and the reflex of autonomic nervous system. Besides, it has mild influences on the respiratory system and circulatory system and it is often used in conjunction with propofol for TIVA, leading to a preferable anesthetic effect (Johanning, 2022). In clinical anesthesia practices, however, TIVA alone has a limited blocking effect on the low-grade central conduction system and some patients with poor tolerance may experience obvious stress responses, resulting in great fluctuations in hemodynamics, which is not conducive to the smooth progress of surgery and the improvement of patients' prognosis and may adversely affect postoperative inflammatory responses, stress responses, immune responses and other systems. It was pointed out in a study that the combination of TIVA with TAPB can stabilize intraoperative hemodynamic indexes, beneficial to increasing the effectiveness and safety of anesthesia (Xue *et al*., 2022).

The results of this study manifested that both groups had higher HR and MAP at T_1-T_2 than at T_0 and gradually falling HR and MAP at T_3 and T_4 compared with those at T_2. Besides, the two indexes were higher in control group than those in research group, confirming that the combined TAPB can stabilize the intraoperative hemodynamic indexes. The reason is that ultrasound-guided TAPB can clearly display the anatomic relationship between the course of transversus abdominis nerves and the surrounding tissues, thereby accurately finding out the target nerve. Then, under ultrasound guidance, local anesthetics can be precisely injected into the periphery of the target neural structure between muscles to fully infiltrate the nerve and exert the blocking effect on the sympathetic transduction pathway in a short period of time, thus effectively disconnecting the nerve conduction of surgical traumatic stimulation, avoiding the sensitization of the central nervous system and reducing the traumatic stress response during operation. Moreover, the combination of etomidate with TIVA can efficiently enhance the anesthetic and sedative effects, which can better stabilize the hemodynamic indexes during operation (Zhu *et al*., 2025; Huang *et al*., 2023).

Studies have denoted that intense surgical traumatic stimulation can activate the complement activation pathway in the body and induce monocytes and macrophages to release relevant inflammatory factors (*e.g.*, hs-CRP and TNF-α) and excessive inflammatory responses may trigger systemic inflammatory response syndrome, which is detrimental to patients' postoperative recovery (Silva *et al*., 2024; Vandendriessche *et al*., 2024). In addition, some studies revealed that traumatic surgical stimulation can not only activate the sympathetic nerves and the renin-angiotensin-aldosterone system, but also cause excitation of the Locus ceruleus norepinephrine system and increase the plasma concentration of catechol, further stimulating the release of corresponding stress hormones (including MDA and Cor) into the blood, exacerbating the pain after traumatic surgery and in turn, aggravating the inflammatory and stress responses in organisms (Kelliher and Scott, 2022; Spencer and Scott, 2022). According to the results of this study, the serum hs-CRP, TNF-α, MDA, Cor, PGE_2 and SP levels in research group were lower than those in control group at 24 h after operation, suggesting that etomidate combined with TAPB applied to radical resection of ovarian cancer can help reduce postoperative pain sensation and inhibit postoperative inflammatory and oxidative stress responses. The related reason is that postoperative stress and inflammatory responses are mainly attributed to traumatic manipulations during operation and postoperative incision pain. Moreover, TAPB can directly impact on the anterior branches of the thoracolumbar nerves, effectively obstruct the nociceptive transmission by peripheral nerves on the anterior abdominal wall and mitigate the pain sensation in the body while effectively decreasing the release of inflammatory factors and stress hormones in organisms (Yoon *et al*., 2022).

Table 1: Baseline data of patient

Baseline data		Control group (n=45)	Research group (n=45)	Statistical value	P. value
Age ($\bar{x} \pm s$, year)		35.24±3.26	35.08±3.41	t=0.228	0.821
Tumor diameter ($\bar{x} \pm s$, cm)		9.26±1.52	9.24±1.50	t=0.063	0.950
Pathologic stage [n (%)]	Stage I	30 (66.67)	32 (71.11)	χ^2=0.207	0.649
	Stage II	15 (33.33)	13 (28.89)		
Body mass index ($\bar{x} \pm s$, kg/m^2)		22.09±0.52	22.06±0.53	t=0.271	0.787

Table 2: Hemodynamic indexes at different time points ($\bar{x} \pm s$)

Group	n	Time point	HR (beat/min)	MAP (mmHg)
Control	45	T_0	92.26±10.45	105.24±11.20
		T_1	99.46±8.54	110.42±12.13
		T_2	102.28±8.36	118.26±12.71
		T_3	93.24±7.56	113.24±10.57
		T_4	86.24±8.24	106.25±9.24
Research	45	T_0	92.25±10.74	105.20±15.26
		T_1	94.73±8.84	107.24±13.58
		T_2	96.41±10.72	109.75±12.26
		T_3	93.34±8.47	106.45±10.24
		T_4	90.21±7.14	104.24±9.24
F intergroup/P intergroup			1016.489/<0.001	494.942/<0.001
F time point/P time point			497.592/<0.001	224.322/<0.001
F intergroup-time point interaction/P intergroup-time point interaction			1830.091/<0.001	644.330/<0.001

Table 3: Serum-related factors ($\bar{x} \pm s$)

Group	n	Hs-CRP (mg/L)		TNF-α (pg/mL)	
		Before operation	24 h After operation	Before operation	24 h After operation
Control	45	3.16±0.62	25.39±1.22[a]	15.25±5.20	68.84±8.85[a]
Research	45	3.19±0.60	15.60±0.68[a]	15.28±5.99	35.26±5.84[a]
t		0.233	47.020	0.025	21.245
P		0.816	0.000	0.980	0.000

[a]P<0.05 *vs.* before operation within the group.

Table 4: Oxidative stress indexes ($\bar{x} \pm s$)

Group	n	MDA (nmol/mL)		Cor (nmol/L)	
		Before operation	24 h After operation	Before operation	24 h After operation
Control	45	6.16±0.60	3.78±0.50[a]	456.83±20.95	680.34±35.64[a]
Research	45	6.11±0.75	1.13±0.20[a]	458.54±20.99	595.24±30.24[a]
t		0.530	33.011	0.387	12.214
P		0.597	0.000	0.700	0.000

[a]P<0.05 *vs.* before operation within the group.

Table 5: Levels of pain mediator indexes ($\bar{x} \pm s$)

Group	n	PGE2 (pg/mL)		SP (ng/mL)	
		Before operation	24 h After operation	Before operation	24 h After operation
Control	45	3.02±0.32	20.32±3.50[a]	81.26±13.33	129.35±10.22[a]
Research	45	3.05±0.28	12.65±2.61[a]	81.19±12.05	96.64±8.95[a]
t		0.473	11.785	0.026	16.152
P		0.637	0.000	0.979	0.000

[a]P<0.05 *vs.* before operation within the group.

Table 6: Immune function indexes ($\bar{x} \pm s$)

Group	n	CD4+ (%)		CD3+ (%)		CD8+ (%)		CD4+/CD8+ ratio	
		Before operation	24 h After operation	Before operation	24 h After operation	Before operation	24 h After operation	Before operation	24 h After operation
Control	45	40.22±5.51	26.65±4.65[a]	68.36±5.01	55.41±4.39[a]	27.52±2.25	37.35±3.31[a]	1.46±0.14	0.71±0.15[a]
Research	45	40.29±4.98	32.65±5.19[a]	68.01±4.98	60.85±5.50[a]	27.68±2.29	32.50±2.30[a]	1.45±0.12	1.00±0.24[a]
t		0.063	5.776	0.332	5.186	0.315	8.072	0.364	6.874
P		0.950	0.000	0.740	0.000	0.753	0.000	0.717	0.000

[a]P<0.05 *vs.* before operation within the group.

Table 7: Incidence rate of adverse reactions [n (%)]

Group	n	Lethargy	Bradycardia	Nausea and Vomiting	Respiratory depression	Dizziness and headache	Delirium	Pruritus	Total
Control	45	0 (0.00)	0 (0.00)	1 (2.22)	0 (0.00)	1 (2.22)	0 (0.00)	0 (0.00)	2 (4.44)
Research	45	0 (0.00)	1 (2.22)	1 (2.22)	0 (0.00)	1 (2.22)	0 (0.00)	1 (2.22)	4 (8.89)
χ^2									0.179
P									0.673

It was researched that the traumatic manipulations of operation can reduce activity of NK cells, resulting in the disturbance of T-lymphocyte subsets and further suppressing the immune function of the body (Mauser *et al*., 2021). The results of this study indicated that the CD4+ and CD3+ levels as well as CD4+/CD8+ ratio were elevated, whereas the CD8+ level was lowered in research group compared with those in control group at 24 h after operation.

It corroborates that etomidate combined with TAPB for radical resection of ovarian cancer can efficiently maintain the stability of immune function. The possible reason is that TAPB can effectively inhibit the inflammatory responses and stress responses in the body by relieving the pain, decrease the release of catecholamine and glucocorticoid and efficaciously reduce the immune damage, thus having a positive effect on the maintenance of the immune function in the body. From the perspective of safety, the incidence rate of adverse reactions in research group was slightly higher than that in control group, but displayed no significant difference, proving that etomidate combined with TAPB for radical resection of ovarian cancer can effectively guarantee the safety of anesthesia. Furthermore, the present findings suggest that the combined use of etomidate and TAPB may have practical implications for perioperative anesthesia management in oncology. By stabilizing intraoperative hemodynamics, attenuating inflammatory and stress responses and preserving immune function, this multimodal protocol may help create a more favorable physiological environment for postoperative recovery and enhance tolerance to adjuvant oncologic therapies. In clinical practice, such integrated anesthesia strategies could potentially reduce postoperative complications, shorten hospital stays and promote enhanced recovery in patients undergoing major oncologic surgeries.

The perioperative immune modulation observed with etomidate plus TAPB, characterized by reduced systemic inflammation and preserved lymphocyte function, may enhance physiological resilience and improve tolerance to adjuvant chemotherapy or radiotherapy. Mechanistically, an attenuated inflammatory and stress response could decrease postoperative complications and fatigue, allowing earlier initiation and higher relative dose intensity of adjuvant therapy. Extending postoperative follow-up to capture parameters such as time to adjuvant therapy, dose modifications, recurrence and survival would clarify whether these perioperative immune and inflammatory improvements translate into durable oncologic benefits.

Although our study did not directly assess tumor tissue, the observed reductions in hs-CRP, TNF-α, PGE2 and SP levels, together with improved T-cell profiles, suggest a less inflammatory and stressful perioperative milieu. Because perioperative inflammation and stress hormones can influence antitumor immunity and stromal signaling, it is plausible that multimodal anesthesia with etomidate plus TAPB might indirectly affect tumor microenvironment remodeling and, consequently, recurrence risk. These effects remain speculative and future studies incorporating perioperative biospecimens and long-term oncologic follow-up are warranted to verify this potential link.

This study has several limitations. First, the study was conducted at a single center with a relatively limited sample size, which may restrict the generalizability of the findings to other populations and surgical settings. Second, the anesthesiologists and evaluators were not blinded to group allocation, potentially introducing observer bias despite objective biochemical endpoints being used. Third, the follow-up was confined to the immediate postoperative period, which precluded the assessment of long-term oncologic outcomes such as time-to-recurrence and overall

survival. Fourth, the lack of patient-reported pain scores (e.g., the Visual Analogue Scale) limits the ability to correlate the measured biochemical markers with the patients' subjective pain experience. Future studies should employ a multicenter, blinded design, incorporate standardized subjective pain scales and extend the follow-up duration to determine whether the observed improvements in immune and inflammatory profiles translate into meaningful clinical benefits, such as enhanced tolerance to adjuvant therapy or improved survival.

CONCLUSION

In summary, etomidate combined with transversus abdominis plane block appeared to provide stable anesthesia, attenuate inflammatory and oxidative stress responses and help preserve immune function in patients undergoing radical resection of ovarian cancer. These findings suggest that this multimodal anesthesia approach may promote a more balanced physiological and immunological recovery in the perioperative period. However, larger multicenter studies with longer follow-up durations and the inclusion of patient-reported pain assessments are warranted to validate these results and explore their potential implications for long-term oncologic outcomes.

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Authors' contributions
Jinshan Xie: Conceptualization, Methodology, Writing – Original Draft. Xiaoli Li: Formal Analysis, Investigation, Data Curation, Writing - Review & Editing. Feng Jian: Validation, Resources, Supervision, Project Administration.

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Data availability statement
The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethical approval
The study was approved by the ethics committee of Zhoukou Central Hospital (No. ACH20220903). All patients in the study signed the informed consent form. This study was performed in adherence with the CONSORT guidelines. See supplementary file for the CONSORT checklist.

Conflict of interest
The authors declare no conflict of interest.

Editorial Note
This trial was registered retrospectively (after participant enrollment began). The journal has verified that prospective ethical approval was obtained from the authors' Institutional Review Board on 03/09/2022. The authors have provided justification for delayed registration. Readers are advised to interpret the findings with awareness of this limitation.

Supplementary data
https://www.pjps.pk/uploads/2026/06/SUP1782203248.pdf

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