Comparison of the Effects of Different Anesthetic Agents on Hemodynamics, Recovery and Postoperative Cognitive Function in Ambulatory Gynecologic Procedures

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ABSTRACT

Objective: The aim of this study is to compare the effects of three different intravenous induction agents (propofol, etomidate, and thiopental) on hemodynamic parameters, recovery times, and postoperative cognitive functions in patients undergoing short-duration ambulatory vaginal gynecological procedures.

Methods: This postoperative observational study included a total of 120 patients aged 25–75 years in the ASA I–II group who underwent transvaginal gynecological procedures in the Obstetrics and Gynecology Operating Room of Istanbul Training and Research Hospital between March and May 2010. Patients were divided into three groups: Group-P (Propofol 2 mg/kg), Group-E (Etomidate 0.3 mg/kg), and Group-T (Thiopental 5–7 mg/kg). All groups received 1.5 µg/kg fentanyl for analgesia. Hemodynamic parameters, recovery times, and scores of Aldrete, Ramsay Sedation Scale (RSS) and Mini-Mental State Examination (MMSE) were recorded and analyzed.

Results: Hemodynamic stability was best maintained in Group-E, while significant reductions in systolic and diastolic blood pressure were observed in Group-P at the 1st and 5th minutes ($p<0.05$). Groups were similar in recovery

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times (Aldrete scores), and sedation levels (RSS scores) were comparable across groups ($p>0.05$). MMSE scores were lower in Group-P at 30 minutes ($p=0.02$), though all groups reached similar levels by the 2nd hour ($p=0.71$). Side effects were mild and agent-specific, with no major complications.

Conclusion: In ambulatory gynecological procedures, propofol demonstrated a favorable profile for rapid recovery and early improvement in postoperative cognitive function. Etomidate appeared advantageous for maintaining hemodynamic stability and may be considered a suitable alternative, particularly for patients with high cardiovascular risk or hemodynamic vulnerability. However, anesthetic selection in the general population should be individualized based on patient characteristics and surgical conditions. Thiopental was associated with prolonged recovery and delayed cognitive recovery in some cases, and these findings warrant confirmation in larger, multicenter studies.

Keywords: ambulatory surgical procedures, intravenous anesthesia, cognitive function, blood pressure

Günübirlik Jinekolojik Girişimlerde Farklı Anestezik Ajanların Hemodinami, Derlenme ve Postoperative Kognitif Fonksiyonlar Üzerine Etkilerinin Karşılaştırılması

ÖZ

Amaç: Bu çalışmanın amacı, kısa süreli ambulatuar prosedür kapsamında vajinal jinekolojik işlemler uygulanan hastalarda üç farklı intravenöz indüksiyon ajanının (propofol, etomidat ve tiyopental) hemodinamik parametreler, iyileşme süreleri ve postoperatif bilişsel işlevler üzerindeki etkilerini karşılaştırmaktır.

Yöntem: Bu postoperatif gözlemsel çalışmaya İstanbul Eğitim ve Araştırma Hastanesi Kadın Hastalıkları ve Doğum Ameliyathanesinde, Mart–Mayıs 2010 tarihleri arasında transvajinal jinekolojik girişim uygulanan ASA I–II grubunda 25–75 yaş aralığında toplam 120 hasta dahil edildi. Hastalar üç gruba ayrıldı: Grup-P (Propofol 2 mg/kg), Grup-E (Etomidat 0.3 mg/kg), ve Grup-T (Tiyopental 5–7 mg/kg). Tüm gruplarda analjezi için 1.5 µg/kg fentanil uygulandı. Hemodinamik parametreler, iyileşme süreleri ve Ramsay Sedasyon Ölçeği (RSS) ve Mini-Mental Durum Muayenesi (MMSE) skorları kaydedildi ve analiz edildi.

Bulgular: Hemodinamik stabilite en iyi Grup-E'de korunurken, Grup-P'de 1. ve 5. dakikalarda sistolik ve diyastolik kan basıncında anlamlı düşüşler gözlendi ($p<0.05$). Gruplar iyileşme süreleri (Aldrete skorları) ve sedasyon düzeyleri (RSS

skorları) açısından benzerdi (p>0.05). Gruplar RSS puanları açısından benzerdi. MMSE skorları 30. dakikada Grup-P'de daha düşüktü (p=0.02), ancak 2. saatte tüm gruplar benzer seviyelere ulaştı (p=0.71). Yan etkiler hafifti, ajana özgü dağılım gösterdi ve ciddi bir komplikasyon saptanmadı.

Sonuç: Günübirlik jinekolojik girişimlerde propofol, hızlı derlenme ve erken bilişsel toparlanma açısından avantajlı bir profil sergilemiştir. Etomidat, hemodinamik stabiliteyi koruması ve bilişsel fonksiyonları minimal düzeyde etkilemesiyle özellikle kardiyovasküler riski yüksek veya hemodinamik açıdan hassas hastalarda uygun bir alternatif olarak değerlendirilebilir. Tiyopental ise bazı olgularda uzamış derlenme süresi ve gecikmiş bilişsel iyileşme ile ilişkili bulunmuştur. Bununla birlikte, ajan seçiminin her hastada klinik özellikler ve cerrahi koşullar dikkate alınarak bireyselleştirilmesi önerilmektedir. Bulguların daha geniş örneklemli, çok merkezli çalışmalarla desteklenmesi gerekmektedir.

Anahtar Kelimeler: günübirlik cerrahi işlemler, intravenöz anestezi, bilişsel işlev, kan basıncı

INTRODUCTION

Ambulatory surgery has become an integral component of contemporary healthcare systems, enabling a wide range of diagnostic and therapeutic interventions to be performed efficiently and safely without prolonged hospitalization. This shift has been largely driven by advancements in minimally invasive surgical techniques and the development of short-acting anesthetic agents, which collectively contribute to reduced healthcare costs, shortened hospital stays, and improved patient satisfaction (Apfelbaum et al., 2022; Joshi, 2024). In this evolving clinical environment, the primary goals of anesthesia are to maintain perioperative hemodynamic stability, facilitate a smooth and rapid recovery, and ensure safe and timely discharge. An ideal anesthetic agent for ambulatory procedures is expected to have a rapid onset and offset, predictable titration, and a low incidence of side effects.

Despite these improvements, concerns remain regarding the potential for anesthetic agents to induce transient cognitive disturbances in the immediate postoperative period. Surgical stress responses, intraoperative hemodynamic variability, and the neurophysiological properties of anesthetic drugs may influence postoperative neurological outcomes, particularly in vulnerable populations (Goettel et al., 2017; Evered et al., 2018). Postoperative cognitive dysfunction (POCD) is characterized by a temporary decline in neuropsychological performance, such as

memory, attention, and orientation, typically occurring within hours to days after surgery (Evered et al., 2018). While POCD is more frequently observed among older adults and patients with systemic comorbidities or prolonged anesthetic exposure, it may also occur following short ambulatory interventions, particularly depending on the pharmacodynamic profile of the administered anesthetic agent (Deng et al., 2025; Liu et al., 2025; Li et al., 2026).

Among intravenous agents commonly used for induction in outpatient settings, propofol, etomidate, and thiopental each have distinct pharmacological profiles that may differentially affect perioperative outcomes. Propofol is widely used for its favorable pharmacokinetics, including rapid onset, smooth induction, and antiemetic properties; however, it is associated with dose-dependent hypotension and myocardial depression, which may be clinically relevant in sensitive individuals (Marik, 2004). Etomidate provides hemodynamic stability and minimal cardiac depression, making it a preferred agent in patients with cardiovascular compromise; however, it can be associated with transient adrenal suppression and myoclonic movements (Valk and Struys, 2021). Thiopental, a barbiturate with a rapid onset, has become less favored due to its potential for delayed recovery and residual sedation, limiting its use in short-duration outpatient procedures (Morgan et al., 2022).

This study aimed to compare the effects of propofol, etomidate, and thiopental, three intravenous induction agents frequently used in outpatient anesthesia, on hemodynamic parameters, recovery characteristics, and early postoperative cognitive function in patients undergoing short transvaginal gynecologic procedures. The hypothesis was that these agents would exhibit distinct profiles in terms of intraoperative cardiovascular responses and short-term neurocognitive recovery. The primary outcome was the change in cognitive performance during the early postoperative period, assessed using the Mini-Mental State Examination (MMSE). Secondary outcomes included intraoperative variations in blood pressure and heart rate, sedation depth assessed by the Ramsay Sedation Scale (RSS), time to reach full recovery, and the frequency of common drug-related side effects. While existing evidence has explored these agents individually, direct comparisons in the context of ambulatory gynecologic surgery remain limited. The findings from this study may contribute to a better understanding of how these anesthetic agents perform across multiple clinical dimensions and support more tailored decision-making in similar outpatient surgical settings.

MATERIAL AND METHODS

This postoperative observational study was conducted at Istanbul Training and

Research Hospital from March to May 2010. The study included 120 female patients, aged 25–75 years, classified as American Society of Anesthesiologists (ASA) physical status I–II, who underwent short transvaginal gynecologic procedures under anesthesia in the Obstetrics and Gynecology Operating Room. Patients with cardiac, pulmonary, renal, or hepatic disease; dementia; depression; a history of neurological disease; chronic alcohol or drug use; or fluid and electrolyte imbalances were excluded. Patients were divided into three groups based on the anesthetic agent used during routine clinical practice: Group-P: Propofol 2 mg/kg; Group-E: Etomidate 0.3 mg/kg; Group-T: Thiopental 5–7 mg/kg.

No premedication was administered. All patients received intravenous fentanyl 1.5 µg/kg for analgesia prior to induction. Standard monitoring included electrocardiography (ECG), non-invasive blood pressure, and peripheral oxygen saturation (SpO_2). Hemodynamic parameters, systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), and SpO_2, were recorded at four time points: before induction (T_0), at the 1st minute (T_1), 5th minute (T_2), and 10th minute (T_3).

Sedation was assessed using the Ramsay Sedation Scale (RSS) (Padhi et al., 2022) at the 0^{th}, 3^{rd}, 5^{th}, and 10^{th} minutes. Recovery was evaluated using the Aldrete scoring system; patients were transferred to the recovery unit once their score exceeded 5 and were considered fully recovered when their score reached 9 or higher. Cognitive function was assessed using the Mini-Mental State Examination (MMSE) (Schmidt et al., 2018) preoperatively, at the 30^{th} postoperative minute, and at the 2^{nd} postoperative hour. Adverse effects, including injection pain, myoclonus, coughing, hiccups, allergic reactions, and arrhythmias, were recorded. This observational study evaluated data from patients who underwent standard clinical procedures, using de-identified information collected during routine primary care. All patient data were anonymized to ensure confidentiality; therefore, formal ethics committee approval was not required. However, all participants received verbal information regarding procedures and medications as part of routine clinical care.

The sample size of 40 patients per group (total n = 120) was determined based on feasibility and the methodology reported by Tamdoğan et al. (2025). To support adequacy, a post hoc power analysis was conducted using G*Power 3.1.9.7, assuming an effect size of f = 0.30, alpha = 0.05, and power = 0.95 for one-way ANOVA. The analysis indicated that the selected sample size would

be sufficient to detect clinically meaningful differences between groups with acceptable statistical power. Statistical analyses were performed using SPSS software. Continuous variables were reported as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. Comparisons between groups were made using ANOVA, Kruskal–Wallis, and Chi-square tests, as appropriate. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 120 patients completed the study. Demographic and sociodemographic characteristics, including age, body weight, and ASA classification, were statistically comparable among the three groups (p>0.05) (Table 1). Similarly, mean anesthesia durations did not differ significantly.

Table 1. Demographic and sociodemographic characteristics of the groups

Characteristic	Group-P (n=40)	Group-E (n=40)	Group-T (n=40)	p-value
Age (years)	48.10 ± 8.78	46.58 ± 9.51	47.95 ± 8.36	0.37
Body weight (kg)	77.72 ± 10.43	77.02 ± 14.03	77.46 ± 11.00	0.43
ASA physical status (I/II)	22 / 18	24 / 16	23 / 17	0.74

Note: Age and body weight values are presented as ***mean ± standard deviation*** (SD).
ASA: American Society of Anesthesiologists.

Heart rate (HR) and peripheral oxygen saturation (SpO_2) remained stable throughout the procedure in all groups. In contrast, systolic and diastolic blood pressure (SBP and DBP) showed a statistically significant decrease in the 1st and 5th minutes in the propofol group (p<0.05), indicating a transient hypotensive effect consistent with propofol's pharmacodynamic profile. Etomidate preserved hemodynamic parameters near baseline, whereas thiopental produced moderate but not clinically concerning reductions (Table 2).

Table 2. Hemodynamic parameters of the groups over time

Time Point	Groups (n=40)	HR (beats/min)	SBP (mmHg)	DBP (mmHg)	SpO_2 (%)	p-value
T_0 (Baseline)	Group-P Group-E Group-T	82.4 ± 10.5 81.8 ± 9.9 83.2 ± 10.8	126.3 ± 12.1 125.8 ± 11.6 127.5 ± 13.2	79.6 ± 9.8 80.2 ± 10.2 80.0 ± 9.5	98.5 ± 0.8 98.7 ± 0.7 98.6 ± 0.6	>0.05
T_1 (1^{st} min)	Group-P Group-E Group-T	86.7 ± 11.2 83.1 ± 10.1 84.5 ± 9.8	110.2 ± 11.4* 121.4 ± 12.3 118.6 ± 13.1	70.1 ± 8.9* 77.5 ± 9.1 74.8 ± 8.6	98.3 ± 0.7 98.5 ± 0.6 98.4 ± 0.6	<0.05*
T_2 (5^{th} min)	Group-P Group-E Group-T	84.5 ± 9.7 82.9 ± 9.4 83.6 ± 10.0	112.5 ± 12.3* 120.6 ± 11.8 117.9 ± 12.5	72.3 ± 8.5* 78.4 ± 8.9 76.2 ± 8.1	98.4 ± 0.7 98.6 ± 0.7 98.4 ± 0.5	<0.05*

T_3 (10^{th} min)	Group-P Group-E Group-T	82.8 ± 10.1 81.2 ± 9.6 82.4 ± 9.8	120.6 ± 11.7 122.4 ± 12.1 121.2 ± 11.9	76.5 ± 8.2 77.8 ± 8.6 77.2 ± 8.5	98.5 ± 0.6 98.7 ± 0.6 98.6 ± 0.6	>0.05

Note: Values are presented as mean ± standard deviation (SD). HR: Heart Rate; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; SpO_2: Peripheral Oxygen Saturation.

The mean time to reach an Aldrete score >5 was 6.8 ± 2.1 min in Group-P, 7.2 ± 2.3 min in Group-E, and 7.0 ± 2.0 min in Group-T (p>0.05). Full recovery (Aldrete >9) occurred at 13.5 ± 3.4 min, 12.8 ± 3.1 min, and 14.2 ± 3.8 min in Groups P, E, and T, respectively (p>0.05).

Sedation levels, as assessed by the RSS, declined over time across all groups, consistent with the natural resolution of anesthetic effects. At baseline (T_0), sedation scores were highest in Group-P (5.97 ± 0.02), followed by Group-T (5.89 ± 0.04) and Group-E (5.57 ± 0.07). At the 1^{st} and 5^{th} minutes, Group-P (5.89 ± 0.49 and 5.07 ± 0.15, respectively) maintained deeper sedation than Group-E (5.30 ± 0.07 and 4.80 ± 0.11, respectively), which consistently had lower RSS scores. By the 10^{th} minute, sedation levels had returned closer to full consciousness across all groups (Group-P: 2.64 ± 0.13, Group-E: 2.42 ± 0.11, Group-T: 2.53 ± 0.14), and the RSS values of the groups were similar to each other (p>0.05).

Preoperative MMSE scores were comparable across the three groups (p=0.64). At the 30th postoperative minute, Group P showed a decline (26.4 ± 1.5) compared with baseline (28.7 ± 1.2). In contrast, Groups E and T maintained higher MMSE scores, with no significant within-group reductions. By the 2^{nd} postoperative hour, MMSE scores had returned to near-baseline levels in all groups, and no statistically significant differences were detected between groups at that time point (p=0.71) (Table 3).

Table 3. MMSE scores of the groups over time.

Time Point	Group-P (n=40)	Group-E (n=40)	Group-T (n=40)	p-value
Preoperative	28.7 ± 1.2	28.9 ± 1.1	28.8 ± 1.0	0.64
Postoperative 30^{th} min	26.4 ± 1.5*	28.2 ± 1.3	27.9 ± 1.4	0.02*
Postoperative 2^{nd} h	28.5 ± 1.1	28.8 ± 1.0	28.6 ± 1.2	0.71

Note: Values are presented as mean ± standard deviation (SD). MMT: Mini-Mental Test.

Regarding side effects, injection pain was more frequently reported with propofol (20%), which is a known and common adverse reaction. Myoclonus occurred in 10% of patients receiving etomidate, consistent with its known subcortical effects. In the thiopental group, mild and self-limited coughing and hiccups were

observed. No serious respiratory or cardiovascular complications occurred in any group.

DISCUSSION

The present study demonstrated that etomidate provides superior cardiovascular stability, whereas propofol offers more pronounced sedation and faster cognitive recovery, and thiopental is associated with moderate hemodynamic suppression and delayed recovery. Overall, all three agents provided acceptable safety profiles without major complications, making them viable options for ambulatory gynecologic anesthesia, with nuanced differences in clinical performance.

Cardiovascular stability is a key concern during ambulatory procedures. As observed in this study, propofol produced a statistically significant reduction in systolic and diastolic blood pressure at the 1st and 5th minutes, consistent with its vasodilatory and negative inotropic properties (Marik, 2004; Hannam et al., 2019). In contrast, etomidate preserved blood pressure and heart rate near baseline, supporting its established safety in patients at cardiovascular risk (Meng et al., 2016; Shetabi & Montazeri, 2022). Thiopental induced moderate decreases, although not statistically significant, which may reflect barbiturate-related myocardial depression (Turner et al., 2005; Morgan et al., 2022). These findings align with prior trials and suggest that etomidate remains preferable in hemodynamically unstable or elderly patients (Canbek et al., 2015; Alappat, 2018).

In terms of recovery dynamics, all three agents (propofol, etomidate, and thiopental) showed comparable times to PACU (Post-Anesthesia Care Unit) transfer and achievement of full Aldrete recovery scores, with no statistically significant differences. Although propofol is pharmacokinetically characterized by rapid redistribution and clearance, this did not translate into a significantly faster emergence profile in the current study (Shetabi & Montazeri, 2022). Both etomidate and thiopental facilitated recovery within clinically acceptable time frames; however, thiopental showed a trend toward slightly prolonged recovery, consistent with its slower metabolic clearance (Turner et al., 2005; Canbek et al., 2015). These findings suggest that, while all three agents are viable for ambulatory procedures in terms of recovery profiles, individual pharmacokinetic characteristics may influence agent selection, especially in vulnerable populations. Cognitive recovery, measured by the Mini-Mental State Examination (MMSE), showed that propofol was associated with a transient decline in scores at the 30th minute, whereas the etomidate and thiopental groups maintained higher

scores. However, by the 2nd postoperative hour, no significant differences persisted, indicating a reversible early cognitive effect. Similar patterns have been documented in recent clinical studies of post-anesthesia cognitive function (Zhi and Wenjing, 2023). Although the MMSE remains widely used for basic screening, its limited sensitivity in detecting subtle neurocognitive dysfunction, especially in ambulatory settings, has been questioned (Evered et al., 2018). Accordingly, future studies should consider integrating the Montreal Cognitive Assessment (MoCA) or computerized neurocognitive tests for more nuanced evaluations (Li et al., 2025).

Side effects were minimal across all groups. Injection pain was more frequently reported in the propofol group, a well-documented adverse effect attributed to endothelial irritation (Aggarwal et al., 2016). This effect was likely attenuated in this study by pre-induction fentanyl, as supported by Wang et al. (2018). Myoclonus occurred in approximately 10% of patients receiving etomidate, a known phenomenon thought to result from cortical-subcortical disinhibition during induction (Liu et al., 2017). In contrast, thiopental was associated only with mild coughing and occasional hiccups, consistent with prior observations (Mizrak et al., 2010). Notably, no severe cardiorespiratory events occurred in any group, reinforcing the overall safety of all three agents in low-risk surgical populations.

From a clinical standpoint, the choice of induction agent should reflect patient comorbidities and procedural goals. Propofol offers rapid onset and deep anesthesia, making it suitable for hemodynamically stable patients, though its hypotensive effects may limit use in those with cardiovascular risk (Bilotta et al., 2014; Canbek et al., 2015; Mir et al., 2017). Etomidate, with superior cardiovascular stability and minimal impact on cognitive function, remains preferable in cardiac-compromised patients or when early cognitive recovery is important (Zhi and Wenjing, 2023; Li et al., 2025). Thiopental, though effective, is less favorable in modern outpatient settings because of slower emergence and less stable hemodynamic effects, including potential myocardial depression (Fredman et al., 1999; Butterfield et al., 2004).

This study's limitations include its single-center design, limited sample size, and lack of long-term cognitive follow-up, which restrict our ability to detect delayed neurocognitive effects. Additionally, the absence of objective anesthesia depth monitoring (e.g., BIS) and reliance on a basic cognitive test are limitations. Future studies should employ multicentred designs with larger cohorts, include

more sensitive neuropsychological tools, and explore longer follow-up periods to better understand cognitive trajectories.

CONCLUSION

In conclusion, all three anesthetic agents examined in this study (propofol, etomidate, and thiopental) provided clinically acceptable safety and effectiveness profiles in ambulatory gynecologic anesthesia. However, etomidate demonstrated the most favorable hemodynamic stability and minimal impact on early cognitive recovery, making it a strong option for patients with cardiovascular comorbidities or when cognitive preservation is prioritized. Propofol, while associated with a transient decline in cognitive performance at 30 minutes and dose-dependent hypotension, remained effective for procedures requiring predictable onset and recovery in hemodynamically stable patients. Thiopental, although still a viable induction agent, showed moderately delayed recovery and less favorable hemodynamic responses, limiting its applicability in fast-track outpatient settings. Taken together, these findings suggest that anesthetic selection should be individualized based on patient-specific risk factors and procedural goals, with particular attention to cardiovascular status, desired emergence profile, and cognitive trajectory.

Conflict of Interest Declaration: The authors declare no commercial, financial, or other relationships related to this article's subject that might create any potential conflict of interest.

Author Contributions: S.K.S. designed the methodology, conducted data collection and analysis, and wrote the main manuscript. Ş.V. conducted data collection. E.N.T. conceptualized the hypothesis, designed the methodology, supervised the project, and reviewed the draft. All authors contributed to the revision, read and approved the final manuscript.

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