ORIGINAL ARTICLE

# Comparative Analysis of General vs. Spinal Anesthesia on Neonatal Outcomes in Cesarean Sections: A Retrospective Study

Sezaryen Doğumlarda Genel ve Spinal Anestezinin Yenidoğan Sonuçlarına Etkisinin Karşılaştırmalı Analizi

**Ahmet Beyazıt** **Hasan Cem Sevindik** **Sergen Karaali**

**Kenan Serdar Dolapçıoğlu** **Oya Soylu Karapınar** **Arif Güngören**

1- Hatay Mustafa Kemal University Department of Obstetrics and Gynecology Hatay, Türkiye

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**Correspondence:**
Ahmet Beyazıt, Alahan, Hatay Cd. No:203, 31001 Alahan Köyü/Antakya/Hatay, Türkiye

**E mail:** beyazitahmet@hotmail.com

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***ABSTRACT***

***Objective:*** *This study compared the effects of general and spinal anesthesia on neonatal outcomes, including APGAR scores and neonatal intensive care unit (NICU) admission rates, in a large series of cesarean deliveries.*

***Material and Method:*** *A retrospective analysis of electronic medical records of patients who underwent cesarean section at a university hospital between January 2010 and December 2024 was conducted. Patients over 18 years of age with live births after 20 weeks of gestation were included. Demographic data, cesarean section number, indication, anesthesia type, and neonatal outcomes (Apgar scores and NICU admission) were recorded. Statistical analysis was performed using SPSS version 22.0.*

***Results:*** *A total of 3,876 pregnant women were included in the study. The mean Apgar scores at 1 and 5 minutes were significantly lower in the general anesthesia group compared to the spinal anesthesia group (1st 7.41±1.5/7.55±1.07; 5th 8.53±1.07/8.75±0.84; p<0.001). The NICU admission rate was 26.4% in the general anesthesia group and 22.8% in the spinal anesthesia group (p=0.009). Logistic regression analysis revealed that the risk of NICU admission was 1.214 times higher in the general anesthesia group (OR:1.214; 95% CI:1.049-1.405, p=0.009).*

***Conclusion:*** *The choice of anesthesia for cesarean section has significant effects on neonatal health. Spinal anesthesia provides superior results in terms of both Apgar scores and NICU admission rates compared to general anesthesia. Based on these results, spinal anesthesia should be the first choice for elective cesarean sections, and even in emergency situations, spinal anesthesia should be preferred when there are no contraindications.*

***Keywords:*** *Cesarean Section; General Anesthesia; Spinal Anesthesia; APGAR*

***ÖZET***

***Amaç:*** *Bu çalışmada, geniş bir sezaryen doğum serisinde, genel ve spinal anestezinin APGAR skorları ve yenidoğan yoğun bakım ünitesine (YYBÜ) kabul oranları gibi kritik yenidoğan sonuçları üzerindeki etkilerinin karşılaştırılması amaçlanmıştır*

***Gereç ve Yöntem:*** *Ocak 2010 ile Aralık 2024 tarihleri arasında bir üniversite hastanesinde sezaryen doğum gerçekleştirilen hastaların elektronik tıbbi kayıtları retrospektif olarak incelendi. 18 yaşından büyük ve gebeliğin 20. haftasından sonra canlı doğum yapan hastalar çalışmaya dahil edildi. Hastalara ait demografik veriler, sezaryen sayısı, endikasyonu, anestezi tipi ve yenidoğan sonuçları (APGAR skorları ve YYBÜ'ye kabul) kaydedildi. İstatistiksel analizler SPSS versiyon 22.0 programı kullanılarak yapıldı.*

***Bulgular:*** *Çalışmaya toplam 3876 gebe dahil edildi. Birinci ve beşinci dakika ortalama APGAR skorları, genel anestezi grubunda spinal anestezi grubuna göre daha düşüktü (1st 7.41±1.5/7.55±1.07; 5th 8.53±1.07/8.75±0.84; p<0.001). YYBÜ'ye kabul oranı, genel anestezi grubunda %26,4, spinal anestezi grubunda %22,8 olarak bulundu (p=0,009). Lojistik regresyon analizinde, genel anestezi grubunda YYBÜ'ye kabul riskinin 1,214 kat daha yüksek olduğu belirlendi (OR:1.214; 95% CI:1.049-1.405, p=0.009).*

***Sonuç:*** *Sezaryen doğumlarında tercih edilen anestezi yöntemi, yenidoğan sağlığı üzerinde önemli etkilere sahiptir. Spinal anestezi hem APGAR skorları hem de YYBÜ'ye kabul oranları açısından genel anesteziye göre daha iyi sonuçlar sağlamaktadır. Bu sonuçlara göre, elektif sezaryenlerde spinal anestezi birinci seçenek olmalı, acil durumlarda da kontrendikasyon olmadığı sürece spinal anestezi tercih edilmelidir.*

***Anahtar Sözcükler:*** *Sezaryen; Genel Anestezi; Spinal Anestezi, APGAR*

## INTRODUCTION

Cesarean delivery serves as a vital surgical intervention when vaginal birth is not viable due to complications involving the mother or fetus (1). The global rise in cesarean rates has been notable in recent years (2). Turkey, in particular has the highest rate among Organisation for Economic Co-operation and Development (OECD) countries, standing at 53% (3). This trend accentuates the critical need for selecting an anesthesia method that maximizes safety and comfort for both the mother and the infant during the procedure (4). Although cesarean sections can be life-saving, they are not without risks, as they can lead to maternal and fetal morbidity and mortality related to both the surgical process and the anesthesia used (1). Therefore, the choice of anesthesia should be made with careful consideration of its potential effects on both the mother and the newborn.

Cesarean surgery primarily employs two anesthesia techniques: general anesthesia (GA) and regional anesthesia, which includes spinal, epidural, or combined spinal-epidural methods (2). While GA is advantageous due to its rapid onset,

it poses significant risks for pregnant patients, such as difficult intubation, aspiration of gastric contents, and transplacental passage of anesthetic agents, potentially resulting in neonatal respiratory depression (1). In contrast, regional anesthesia, particularly spinal anesthesia (SA), is often favored in elective cesarean procedures due to benefits such as allowing maternal consciousness, facilitating early mother-infant bonding, reducing the need for systemic medication, and presenting a lower risk of respiratory complications (4). Nevertheless, a well-documented side effect of SA is maternal hypotension resulting from sympathetic blockade, which may impact uteroplacental blood flow (5).

One of the most commonly utilized parameters for evaluating the impact of anesthesia methods on neonates is the APGAR score. Numerous studies in the literature have examined the influence of anesthesia choice on APGAR scores, with these studies reporting conflicting results (3,6). These divergent findings suggest that discussions regarding the optimal choice of anesthesia remain ongoing.

This study seeks to retrospectively analyze a substantial series of patients to compare the effects of cesarean sections conducted under general versus spinal anesthesia on critical neonatal outcomes, specifically focusing on newborns APGAR scores and admission rates to the neonatal intensive care unit (NICU). Additionally, this research aims to contribute to the existing literature by providing data from our clinic to address the conflicting findings reported in previous studies.

## MATERIALS AND METHODS

For this retrospective study, the electronic medical records of patients who underwent cesarean delivery at a Hatay Mustafa Kemal University Teaching and Research Hospital from January 2010 to December 2024 were examined. Ethical approval was secured from the university's ethics committee (decision dated 30.07.2025, number 34), and the study adhered to the principles outlined in the Declaration of Helsinki. Inclusion criteria encompassed patients over 18 years of age who experienced live births after 20 weeks of gestation and whose complete data were accessible. Exclusion criteria included patients under 18 years of age, those with stillbirths, patients with congenital fetal anomalies, those who received combined spinal-epidural anesthesia, and those who required conversion to general anesthesia due to unsuccessful spinal anesthesia.

Patients receiving spinal anesthesia were positioned in the lateral decubitus position. A puncture was performed at the L3-L4 or L4-L5 level using a 25G needle, and 10-12.5 mg of hyperbaric bupivacaine (0.5%) was administered. The sensory block level was adjusted to T4-T6. For patients who underwent general anesthesia, preoxygenation was followed by induction with propofol (2-2.5 mg/kg) and succinylcholine (1-1.5 mg/kg). Post-intubation, anesthesia was maintained with a 50% nitrous oxide-oxygen mixture and sevoflurane (0.5-1.0%).

Patient data were retrospectively collected from electronic medical records. Recorded data included demographic information, number of cesarean sections, indication, type of anesthesia, and neonatal outcomes (APGAR score and NICU admission).

### Statistical Analysis

The study's analysis was performed utilizing the Statistical Package for Social Science (SPSS) version 22.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages, whereas continuous variables were described using mean, standard deviation, median, and range (minimum-maximum values). The normality of the distribution of continuous variables was evaluated through the Kolmogorov-Smirnov test. For the comparison of group means, the Mann-Whitney U test was applied for independent two-group comparisons. The Pearson Chi-Square Test was employed for the analysis of categorical data. Logistic Regression analysis was conducted to calculate the Odds Ratio (OR) and 95% Confidence Interval (CI) for factors influencing NICU admission. A p-value of less than 0.05 was considered statistically significant for all analyses.

## RESULTS

The study encompassed a total of 3.876 pregnant women. The mean age of the participants was 29.56±5.96 years, with an average of 2.60±1.34 cesarean sections per participant. The mean gestational age was 37.00±2.31 weeks. Upon evaluation of gestational weeks, it was observed that 6.9% (n=267) of the pregnancies were less than 34 weeks, 21.3% (n=827) were between 34 and 37 weeks, 70.0% (n=2713) were between 37 and 40 weeks, and 1.8% (n=69) exceeded 40 weeks. The most prevalent indication for cesarean section was a previous cesarean section, accounting for 71.5% (n=2771) of cases. It was determined that 48.7% (n=1886) of the participants received general anesthesia, while 51.3% (n=1990) received

**Table 1:** Demographic characteristics of pregnants.

| Variables (n=3876) | Mean ±SD | Median (min-max) |
|---|---|---|
| **Age (years)** | 29.56±5.96 | 29 (18-55) |
| **Number of Cesarean Section** | 2.60±1.34 | 2 (1-8) |
| **Gestational Weeks** | 37.00±2.31 | 38 (22-42) |
| **APGAR 1st minute** | 7.48±1.30 | 8 (1-10) |
| **APGAR 5th minute** | 8.64±0.97 | 9 (1-10) |
| **Gestational Weeks group** | | **n (%)** |
| <34 | | 267 (6.9) |
| 34-37 | | 827 (21.3) |
| 37-40 | | 2713 (70.0) |
| >40 | | 69 (1.8) |
| **Indication for Cesarean Section** | | |
| Prior Cesarean Section delivery | | 2771 (71.5) |
| Placenta previa | | 276 (7.1) |
| Fetal distress | | 173 (4.5) |
| CPD | | 176 (4.5) |
| Malpresentation | | 144 (3.7) |
| Labor arrest | | 72 (1.9) |
| Preeclampsia-Eclampsia-HELLP syndrome | | 46 (1.2) |
| Abruptio placentae | | 41 (1.1) |
| Multiple pregnancies | | 37 (1.0) |
| Prior uterine surgery (myomectomy etc.) | | 8 (0.2) |
| Cord prolapse | | 2 (0.1) |
| Other indications | | 130 (3.4) |
| **Type of Anesthesia** | | |
| General | | 1886 (48.7) |
| Spinal | | 1990 (51.3) |

*SD: Standard deviation CPD: Cephalopelvic disproportion NICU:neonatal intensive care unit min-max: minimum-maximum*

**Table 2:** Clinical characteristics of newborns.

| Variables (n=3876) | N (%) |
|---|---|
| **APGAR 1st minute group** | |
| Low (0-3) | 62 (1.6) |
| Medium (4-6) | 623 (16.1) |
| High (7-10) | 3191 (82.3) |
| **APGAR 5th minute group** | |
| Low (0-3) | 12 (0.3) |
| Medium(4-6) | 100 (2.6) |
| High (7-10) | 3764 (97.1) |
| **NICU admission** | |
| Yes | 952 (24.6) |
| No | 2924 (75.4) |

*NICU:neonatal intensive care unit*

spinal anesthesia (Table 1). Analysis of the APGAR scores revealed a mean score of 7.48±1.30 at 1 minute and 8.64±0.97 at 5 minutes. Additionally, 24.6% (n=952) of the newborns were admitted to the NICU (Table 2).

Table 3 presents comparative data based on the type of anesthesia administered. The analysis reveals statistically significant differences between the groups concerning age (p<0.001), the number of cesarean sections (p<0.001), gestational week (p=0.002), 1st and 5th minute APGAR scores (p<0.001), and NICU admission status (p=0.009) within the general anesthesia group.

Table 4 presents a comparative analysis of demographic and clinical characteristics stratified by NICU admission status. The analysis reveals significant differences between the groups concerning age. the number of cesarean sections. gestational week. and APGAR scores in relation to NICU admission status.

Logistic regression analysis was performed to identify independent risk factors predictive of NICU admission (Table 5). The analysis revealed that the risk of NICU admission among pregnant women who received general anesthesia was 1.214 times higher compared to those who received spinal anesthesia (OR: 1.214; 95% CI: 1.049-1.405, p=0.009).

**DISCUSSION**

This study presents a comprehensive analysis of the impact of spinal versus general anesthesia on neonatal outcomes in a substantial cohort of 3.876 cesarean deliveries. The results demonstrate that the type of anesthesia significantly influences neonatal health, with spinal anesthesia being associated with more favorable neonatal outcomes compared to general anesthesia. A key finding of this investigation is the pronounced effect of anesthesia type on APGAR scores. In the general anesthesia cohort, both the 1st minute (7.41±1.50) and 5th minute (8.53±1.07) APGAR scores were significantly lower than those in the spinal anesthesia cohort (7.55±1.07 and 8.75±0.84, respectively) (p<0.001). These results align with existing literature, as evidenced by the study conducted by Gwanzura et al. in 2023 (8). Concurrently, these findings align with researches conducted in Turkey. Specifically, studies by Kayaaltı and Purtaloğlu also reported significantly higher APGAR scores in neonates, who received spinal anesthesia (9,10). The findings are further accentuated when analyzed categorically. In the general anesthesia group, the incidence

**Table 3:** Analysis of Demographic and Clinical Characteristics Based on Anesthesia Type.

| Variables (n=3876) | General anesthesia | | Spinal anesthesia | | p |
|---|---|---|---|---|---|
| | Mean±SD | Median (min-max) | Mean±SD | Median (min-max) | |
| **Age (years)** | 29.06±6.02 | 29 (18-50) | 30.02±5.87 | 30 (18-55) | <0.001* |
| **Number of Cesarean Section** | 2.18±1.20 | 2 (1-7) | 2.99±1.36 | 3 (1-8) | <0.001* |
| **Gestational Weeks** | 36.95±2.62 | 38 (22-42) | 37.05±1.97 | 38 (25-42) | 0.002* |
| **APGAR 1st minute** | 7.41±1.50 | 8 (1-10) | 7.55±1.07 | 8 (1-10) | 0.001* |
| **APGAR 5th minute** | 8.53±1.07 | 9 (1-10) | 8.75±0.84 | 9 (3-10) | <0.001* |
| **Gestational Weeks group** | **n (%)** | **n (%)** | | | |
| <34 | 169 (9.0) | 98 (4.9) | | | <0.001** |
| 34-37 | 357 (18.9) | 470 (23.6) | | | |
| 37-40 | 1310 (69.5) | 1403 (70.5) | | | |
| >40 | 50 (2.7) | 19 (1.0) | | | |
| **APGAR 1st minute group** | | | | | |
| Low (0-3) | 50 (2.7) | 12 (0.6) | | | <0.001** |
| Medium (4-6) | 340 (18.0) | 283 (14.2) | | | |
| High (7-10) | 1496 (79.3) | 1695 (85.2) | | | |
| **APGAR 5th minute group** | | | | | |
| Low (0-3) | 9 (0.5) | 3 (0.2) | | | <0.001** |
| Medium(4-6) | 80 (4.2) | 20 (1.0) | | | |
| High (7-10) | 1797 (95.3) | 1967 (98.8) | | | |
| **NICU admission** | | | | | |
| Yes | 498 (26.4) | 454 (22.8) | | | 0.009** |
| No | 1388 (73.6) | 1536 (77.2) | | | |

*SD: Standard deviation NICU:neonatal intensive care unit *Mann Whitney U Test. **Pearson Chi-Square Test min-max: minimum-maximum*

**Table 4:** Analysis of Demographic and Clinical Characteristics Based on NICU Admission Status.

| Variables(n=3876) | NICU Yes | | NICU No | | p |
|---|---|---|---|---|---|
| | Mean±SD | Median (min-max) | Mean±SD | Median (min-max) | |
| **Age (years)** | 29.22±6.32 | 29 (18-52) | 29.67±5.84 | 30 (18-55) | 0.008* |
| **Number of Cesarean Section** | 2.42±1.34 | 2 (1-7) | 2.66±1.34 | 2 (1-8) | <0.001* |
| **Gestational Weeks** | 36.30±2.99 | 37 (22-42) | 37.23±1.98 | 38 (22-42) | <0.001* |
| **APGAR 1st minute** | 6.96±1.66 | 7 (1-9) | 7.65±1.11 | 8 (1-10) | <0.001* |
| **APGAR 5th minute** | 8.21±1.35 | 9 (1-10) | 8.78±0.75 | 9 (4-10) | <0.001* |
| **Gestational Weeks group** | **n (%)** | **n (%)** | | | |
| <34 | 140 (14.7) | 127 (4.3) | | | <0.001** |
| 34-37 | 189 (19.9) | 638 (21.8) | | | |
| 37-40 | 610 (64.1) | 2103 (71.9) | | | |
| >40 | 13 (1.4) | 56 (1.9) | | | |
| **Type of Anesthesia** | | | | | |
| General | 498 (52.3) | 1388 (47.5) | | | 0.009** |
| Spinal | 454 (47.7) | 1536 (52.5) | | | |
| **APGAR 1st minute group** | | | | | |
| Low (0-3) | 53 (5.6) | 9 (0.3) | | | <0.001** |
| Medium (4-6) | 221 (23.2) | 402 (13.7) | | | |
| High (7-10) | 678 (71.2) | 2513 (85.9) | | | |
| **APGAR 5th minute group** | | | | | |
| Low (0-3) | 12 (1.3) | 0 (0.0) | | | <0.001** |
| Medium (4-6) | 79 (8.3) | 21 (0.7) | | | |
| High (7-10) | 861 (90.4) | 2903 (99.3) | | | |

*SD: Standard deviation *Mann Whitney U Test. **Pearson Chi-Square Test min-max: minimum-maximum NICU:neonatal intensive care unit*

of low-category APGAR scores was 2.7%, compared to only 0.6% in the spinal anesthesia group. Conversely, the incidence of high-category APGAR scores was 85.2% in the spinal anesthesia group, whereas it was 79.3% in the general anesthesia group (p<0.001). The type of anesthesia also exhibited a significant effect on NICU admission rates. In the general anesthesia group, the rate was 26.4%, compared to 22.8% in the spinal anesthesia group (p=0.009). A recent study by Cocchi et al. in 2025 also reported that general anesthesia increases the risk of NICU admission by 1.8 times (11). Our logistic regression analysis (table 5) yielded similar results, indicating an increase of 1.214 times (OR: 1.214. 95% CI: 1.049-1.305, p=0.009). These findings suggest that the implications of anesthesia choice extend beyond the immediate effects during birth, increasing the likelihood of the newborn requiring intensive care. The elevated NICU admission rate represents a significant financial burden on the healthcare system and a source of stress for families (12,13). Consequently, these findings should be carefully considered in the clinical decision-making process.

**Table 5:** Independent risk factors for predicting NICU admission.

| | OR | %CI | p* |
|---|---|---|---|
| **Age (years)** | 0.992 | 0.979-1.005 | 0.222 |
| **Number of Cesarean Section** | 0.915 | 0.862-0.971 | 0.003 |
| **Gestational Weeks** | 0.926 | 0.895-0.957 | <0.001 |
| **APGAR 1st minute** | 0.926 | 0.834-1.029 | 0.152 |
| **APGAR 5th minute** | 0.677 | 0.586-0.782 | <0.001 |
| **Type of Anesthesia** | | | |
| General | 1.214 | 1.049-1.405 | 0.009 |
| Spinal | 0.824 | 0.712-0.954 | 0.009 |

*OR: Odds Ratio, CI: confidence interval * logistic reggression analysis*

The pathophysiological mechanisms underlying the adverse effects of general anesthesia on neonates are intricate. Primarily, anesthetic agents administered during general anesthesia can traverse the placenta and enter the fetal circulation. Agents such as propofol, thiopental, and inhalational anesthetics readily cross the placental barrier, achieving anesthetic concentrations within the fetal circulation (14). This exposure may result in respiratory depression, cardiovascular alterations, or neurological impacts in the neonate. Notably, the depressive effects on respiration can lead to reduced APGAR scores and an increased requirement for resuscitation, potentially necessitating admission to the NICU (15). Conversely, in the case of spinal anesthesia, the fetal effects are considerably limited due to the minimal transfer of anesthetic agents into the systemic circulation (16). Another significant finding of the study is the lower gestational age observed in the general anesthesia group (36.95±2.62 vs, 37.05±1.97, p=0.002). Notably, the incidence of premature births before 34 weeks is 9% in the general anesthesia group, compared to 4.9% in the spinal anesthesia group (p<0.001). This suggests that cesarean sections utilizing general anesthesia are typically associated with emergency situations or complex cases, such as those involving placenta previa. Interestingly, the mean number of cesarean sections in the general anesthesia group (2.18±1.20) was significantly lower

than in the spinal anesthesia group (3.02±5.87) ($p<0.001$). This finding indicates a preference for spinal anesthesia by either the patient or the physician in cases of repeat cesarean sections.
The association between general anesthesia and emergency cesarean section introduces additional confounding variables that must be considered when interpreting these results. Emergency situations often involve maternal or fetal compromise, which independently increases the risk of adverse neonatal outcomes. Conditions such as fetal bradycardia, cord prolapse, placental abruption, or severe maternal hemorrhage necessitate rapid delivery and may preclude the use of regional anesthesia due to time constraints or contraindications. These underlying pathological conditions, rather than the anesthetic technique itself, may contribute to the observed differences in neonatal outcomes (17).
From a healthcare economics perspective, the reduced NICU admission rates associated with spinal anesthesia translate to substantial cost savings. The average cost of NICU care varies significantly based on the level of care required and duration of stay, but a range from 3000 to 10000 dollars per day (18). A reduction in NICU admissions from 26.4% to 22.8% represents a 3.6 percentage point decrease, which, when applied to a large obstetrics populations, results in considerable healthcare cost reductions and improved resource allocation.
The psychological impact on families should also be considered. NICU admission separates mothers from their newborns during a critical bonding period and can lead to increased maternal anxiety, depression, and difficulties with breastfeeding initiation (19). The reduced NICU admission rates associated with spinal anesthesia may contribute to improved maternal-infant bonding and better early postpartum experiences for families.
The findings of this study suggest that in selecting the type of anesthesia for cesarean operations, it is imperative to consider both maternal factors and neonatal outcomes. Spinal anesthesia is recommended as the primary choice for elective cesarean sections; however, it should also be prioritized in emergency situations whenever feasible. A notable strength of this study is its large sample size, and the single-center design facilitated the standardization of the anesthesia protocol. Nevertheless, the retrospective nature of the study presents a limitation. Furthermore, the association of general anesthesia with emergency situations may introduce higher risk factors in this cohort. The absence of an evaluation of long-term neonatal outcomes is also a significant limitation. Also the study did not evaluate outcomes such as the need for neonatal resuscitation, umbilical cord blood gas analysis, or specific reasons for NICU admission, which could provide more detailed insights into the mechanisms underlying the observed differences.
The findings of this study indicate that the selection of anesthesia in cesarean procedures significantly impacts neonatal health outcomes. Specifically, spinal anesthesia yields superior results compared to general anesthesia, as evidenced by improved APGAR scores and reduced necessity for neonatal intensive care unit (NICU) admission. Consequently, spinal anesthesia should be prioritized in elective cesarean sections. Furthermore, even in emergency scenarios, spinal anesthesia should be favored unless contraindications exist. In instances where general anesthesia is unavoidable, it is imperative to ensure the presence of neonatal resuscitation teams and to plan NICU capacity accordingly.

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**Ethics:** The study was approved by the Hatay Mustafa Kemal University Ethics Committee (Decision number: 34, Date:30.07.2025)
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